Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

APRIL, 1912.

A SIMPLE RECORDING DEVICE FOR ATMOSPHERIC ELECTRICITY.

By CHARLES E. BENHAM.

A SIMPLE form of recording instrument for use with any apparatus that collects atmospheric electricity is of great assistance in studying the subject. The form of collector may be either the water-dropping apparatus invented by Lord Kelvin, or preferably the more recent collector patented by Mr. F. H. Glew, in which the ionisation properties of radio-actives are ingeniously made use of to enable the collecting rod to take up the charges from the atmosphere. The wire from either of these forms of collector may be led through a carefully insulated plug of sulphur into a room to affect a gold leaf electroscope there, and by the attachment here to be described the charges may be made to register themselves automatically.

FIGURE 132.

The first essential is a sort of relay which will operate whenever the atmospheric electrification rises to a given potential. A balance of light wire is made in the form shown in Figure 132, about six inches in length, the extremities being brought just below the level of the axis, so as to ensure stable equilibrium and considerable sensitiveness. One end terminates in a plate of copper foil about two inches square. The other end is soldered to a fine steel needle attached vertically. The axes are two fine points, which rest in a grooved strip of brass, as shown in Figure 133. A counterbalance on the wire is adjusted till the balance will rest horizontally. Underneath the end bearing the steel needle is a small cup of mercury, the needle point being poised about one-sixteenth of an inch above the surface. Under the copper foil at the other end is a metal plate of the same size, insulated and connected with the atmospheric collector. It should be about one-eighth of an inch below the copper foil. It is evident that any electrification of the metal plate will attract the copper foil, and if powerful enough will draw it down until it touches and discharges the lower plate, when it will rebound and cause the needle at the other end to dip into the mercury cup. Wires are attached to this cup and to the central brass strip supporting the axis of the balance, and these wires communicate with a dry cell and an electro-magnet, which is thus brought into action every time the balance discharges the electricity of the collector.

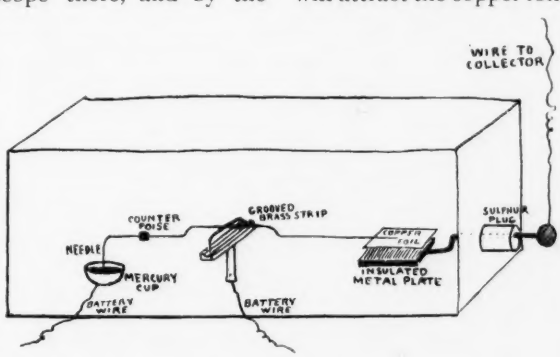

FIGURE 133.

The electro-magnet acts upon an armature that is fixed into a small block of wood mounted on the end of a flat spring about four inches long, so that

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the block is free to move horizontally to and from the magnet. (See Figure 134.) The top of this wooden block is covered with velvet and supports a light lever with glass pen, as shown in the diagram. The lever is counterpoised, and is centrally balanced by two needle-points that rest on the velvet. The pen is a glass tube drawn to a point in a flame and sealed, the sealed end being then ground down carefully on a hone until the aperture is just reached. It is, in fact, the same sort of pen as is used for the harmonograph, and almost any ordinary limpid ink can be used, preferably with a little gum to prevent too free a flow. The pen-point is allowed to rest on a clock-face so as to trace a circle upon it once in twelve hours. At every discharge of the electricity in the relay the electro-magnet is brought into play and the pen-lever on its wooden support is quickly drawn aside, so that a line across the circle is traced. The number and proximity of the cross-lines will, therefore, be proportionate to the amount of electrification of the air, and the exact time of each discharge will be shown by the hour-lines on the dial-face.

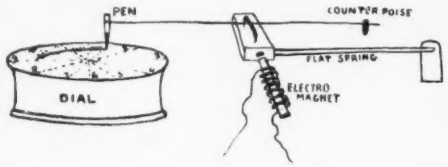

FIGURE 134.

If any difficulty is experienced in making the glass pens the tracing can be done on smoked paper with a needle, but the ink records are obviously more convenient and more easily preserved.

Suppose the apparatus to be set to discharge whenever the potential difference rises to, say, two hundred and ten volts. This can be arranged for by a little trial with an electric light main of that voltage, the distance between the copper foil and the metal plate below it being adjusted until the two hundred and ten volts just suffices to attract the upper plate down to the lower. This having been arranged, it follows that the record of cross lines on the dial will mean that every cross line corresponds to the moment at which the potential difference of the atmosphere was sufficient to charge the instrument up to two hundred and ten volts when it automatically discharged or overflowed. The comparative frequency of the lines in a given interval of time indicates, therefore, the electric condition of the atmosphere.

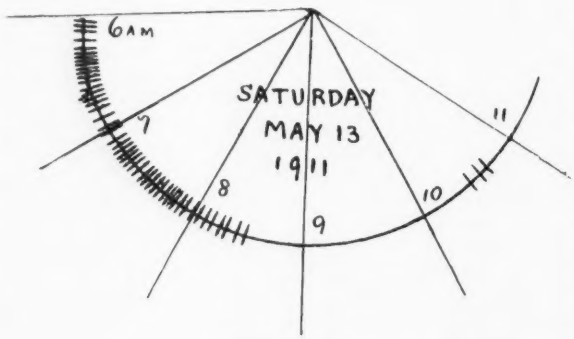

FIGURE 135.

The adjustment of the distance between metal plate and copper foil may be conveniently made by laying thin lead or brass strips on the lower plate until the required level is reached, and the final adjustment may be effected by tilting the relay very slightly by means of a thin wedge inserted under one or the other end.

Unfortunately, the record gives no intimation of the sign of the atmospheric electricity, a somewhat important point from a meteorological aspect, but as a record of mere electric disturbance the apparatus is reliable and interesting, and is very easily constructed.

A specimen of a typical record under normal conditions of the atmosphere is reproduced herewith. (See Figure 135.) Should the electricity be so intense as to make the lines repeat themselves with such frequency that they run into each other, a small Leyden jar may be attached to the collector so as to increase its capacity, and consequently extend the time taken to bring it up to the critical potential difference.

One of the first difficulties with this recorder is the tendency of the relay needle to adhere to the mercury instead of springing back to its position of equipoise, and the result may be that the battery will run down. But this generally results from setting the instrument too close, so that after the discharge it touches the mercury too lightly to withdraw automatically. An effective way of preventing the adherence is to interpose a small trembler bell in the circuit, the bell resting on the top of the relay. It will, of course, ring every time a record is made, and its vibrations, communicated to the needle in the mercury, will act like a decoherer. The bell also has the advantage of adding slightly to the resistance of the circuit, and thus of somewhat lessening the strain on the battery. Two dry cells are ample, and one will generally suffice.

Perhaps the chief difficulty in the whole science and art of collecting atmospheric electricity is that of preventing spider lines from earthing the outdoor part of the collector itself, especially at certain seasons of the year. A single gossamer is enough to stop all signs of electricity, and no matter how high the collecting pole may be it is never out of the reach of the spider, which has a habit of making its web at night, when the automatic recorder should be of the greatest value. Even a coat of bird lime on the pole does not stop the spiders. With a radio-active collector made in windmill form, the difficulty is almost entirely surmounted as the web is broken by the revolution. With the water dropping apparatus, there seems to be no satisfactory way of guarding against spiders' lines.

FIGURE 136. A Sun-dial at Great Edstone.

SAXON SUN-DIALS, MASONS' MARKS, AND CONSECRATION CROSSES.

By LEO L. W. GAYE and ARTHUR GALPIN.

THE curious markings frequently found on, or near, the South Porch of pre-Reformation churches—usually from three feet to six feet from the ground (Figure 137)—have puzzled nearly everyone who has noticed them; and a recent visitor to the parish church of Skeyton, in Norfolk, wrote to a provincial newspaper, asking if anyone could tell him the origin and use of what he had heard described locally as the "Sun-dial." A correspondence was continued for upwards of three months, and showed not only that the subject is interesting to a very large number of persons, but that the utmost confusion exists as to what these "Dials" really are. "Masons' Marks," "Consecration Crosses," "Protractors," and "Sexton's Wheels" were in turn suggested; the only point of agreement being that they are *not* Sun-dials! At the close of the correspondence the writers of the present article began to investigate the subject, and the result of their search for information (in which they have been assisted by clergy and laymen in all parts of Great Britain) has not only proved most interesting, but they have succeeded in answering the original question—"What are these 'dials' and how were they used?"

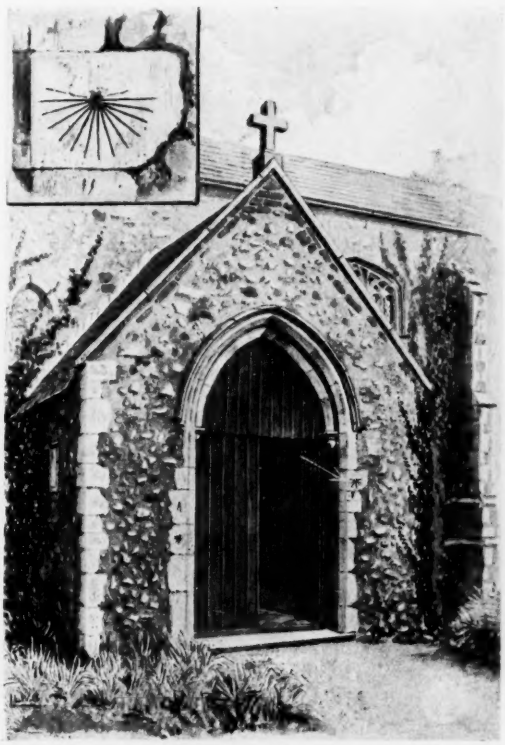

FIGURE 137. Skeyton Porch, showing the position of the Sun-dial.
(The Dial enlarged is shown in the inset).

In considering this subject it is necessary to constantly bear in mind, first of all, the ways of the post-Reformation church restorer. To him is due the "migration of stones," and he appears to have acted upon some such rule as "Here's another stone with something on it; better not throw it away; stick it in *somewhere*; it doesn't matter where" . . . . and in it went! An instance of this is seen at All Saints', Norwich, where five of the original

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FIGURE 138. A Sun-dial at Swardeston.

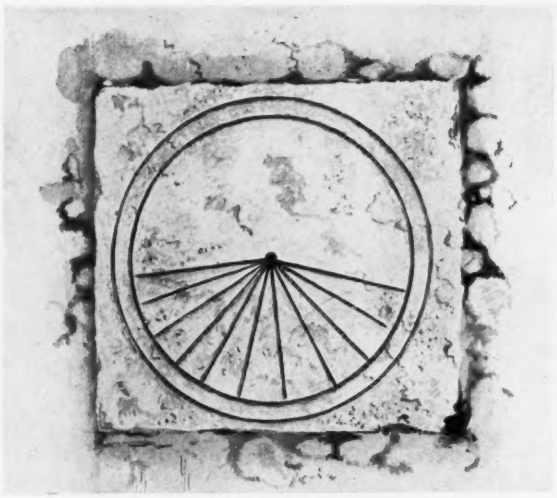

FIGURE 139. A Sun-dial at Great Easton.

consecration crosses (Figure 142) are now in the *outside* wall! This is also the easy explanation of sun-dials being found *inside* churches. Secondly, we must remember that the "Reformers" and their immediate successors have left their trace everywhere; scarcely anything which is sacred or even that which is simply ecclesiologically interesting appears to have escaped them. One finds consecration crosses mutilated, "embellished," and duplicated; sun-dials duplicated (more or less faultily) and originals either mutilated or "improved" by added radii, and so on;

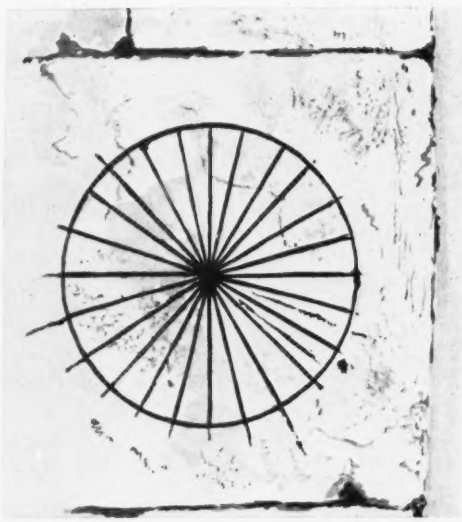

FIGURE 140. A Sun-dial at Tacolneston.

in fact, where the examples are well weathered it is often extremely difficult to distinguish the true from the false.

The suggestion that Saxon dials are consecration crosses found many supporters, but that they were mistaken is easily shewn. The consecration of a Catholic church is a most interesting ceremony occupying several hours, and as all the churches directly or indirectly referred to are pre-Reformation, a brief reference to the crosses (Figures 142–144 and 147 and 148) will be interesting, and will explain what proved a difficulty to so

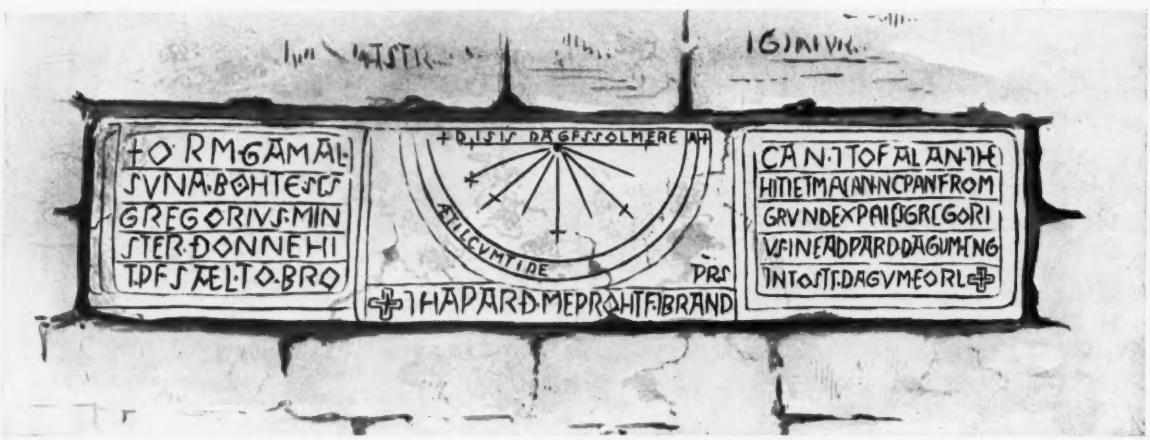

FIGURE 141. A Sun-dial at Kirkdale.

many persons. There are twelve crosses upon the inside *walls* (not on the pillars or columns) —one each side of the main entrance, one each side of the sanctuary, and four upon each side wall. They are seven-feet six-inches from the floor and are sometimes painted upon the walls, sometimes of metal let into the walls, and sometimes cut into the stone (or, if the walls be not of stone, cut into inserted stones). A metal, or wood, sconce (in which a candle is kept burning

FIGURE 142. Consecration Cross at All Saints', Norwich.

oil—as sometimes is also a cross on both door-jambs of the main entrance. These two (which are four-feet six-inches from the ground and have no sconce) are usually, but not always, cut into the jambs; if the jambs are made of brick two small stones (in which the crosses are cut) are let into the bricks. The large number of crosses sometimes found upon door-jambs puzzled many correspondents (one of whom suggested that they are "Institution" crosses, *i.e.*,

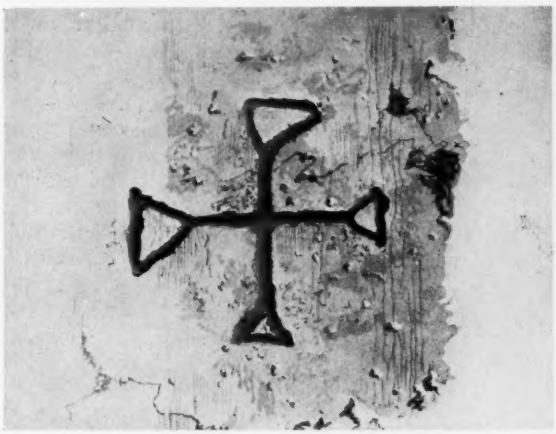

FIGURE 143. Consecration Cross at Rockland, St. Mary.

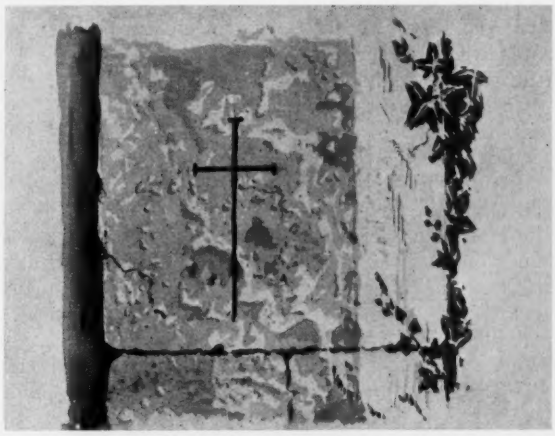

FIGURE 144. Consecration Cross at Skeyton.

from the beginning of the consecration ceremony until the church is closed at night, also all day on the anniversaries of the consecration) is fixed above or below each cross. An interesting exception to this is seen at All Saints', Norwich, where the sconces were in the *centre* of the crosses (Figure 142) as shewn by the remains of the tangs still visible. In the course of the ceremony these twelve crosses are anointed by the Bishop with his thumb dipped in holy

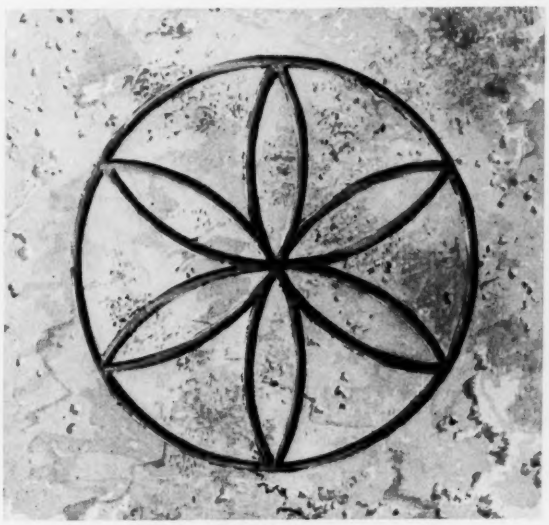

FIGURE 145. Mason's "mark" at Claxton.

whenever a new appointment was made a cross was cut, in commemoration, upon the jambs), but this duplication has been explained when speaking of the "Reformers" as also is the eccentric form some of the original crosses now take.

Those persons who believed the Saxon dials to be "Masons' Marks" were equally mistaken. "Masons' marks" are so varied and numerous as to be countless; and it is customary for a mason to mark, or "sign," his work, just as an artist

XUM

signs his picture. The position of the mason's "mark" has varied from time to time. Apparently, at the beginning of the sixteenth century it was customary for a mason to place his "mark" on the back of stone, and not scratch it upon the face of stonework as was done prior to that period. Figures 151 and 152 are the "marks" of two well-known masons at present living in Norwich (one of whom suggests that Figure 145—which is much more frequently met with than most others — is the "mark" of a masons' guild, *not* of an individual mason), and they are shewn on the joint and top bed of stonework respectively, these being the positions usually occupied by modern masons' "marks."

It was also suggested that the Saxon dials might be primitive "Protractors" by which masons set their "sliding bevels"! In support of this it was pointed out that the angles at which most stones were cut, were multiples of the angle of 15° intercepted by each pair of radiating lines of the dial marks. However, the "marks" selected for illustration (Figures 145 and 149–152), and the many others which have been examined, undoubtedly do away with any justification for entertaining that idea. Apart from the fact that comparatively few of the marks are described sufficiently accurately to allow one to suppose that they were ever put to that purpose successfully, stones—where accuracy was of any moment — would in all probability have been cut to the required angle before leaving the mason's "banker" or bench, and therefore the existence of such a protractor on the site would not be necessary. A measure of proportion by which the parts of an order or of a building are regulated in *classical* architecture also seemed destined to be confused with sun-dials. The measure in question is termed a "module"; it consists of a diameter or semi-diameter of a column and is divided up into sixty equal parts (termed "minutes"). So far as can be discovered the *circumference* of a column has never been taken as the module, but some persons may have had its division in mind when likening such a scale to a sun-dial.

FIGURE 146. Mr. Arthur F. C. Bentley's "Conjectural Method of Fixing the Gnomon."

SUN-DIALS.

The Saxon sun-dials which sometimes have a double and sometimes a single outer circle (Figures 139

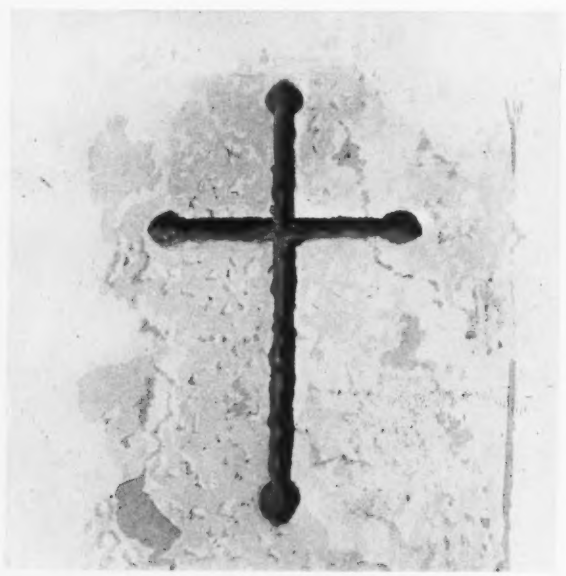

FIGURE 147. Consecration Cross at Kirby Bedon.

FIGURE 148. Consecration Cross at Claxton.

and 140) and which sometimes consist of radii without a circle—or semi-circle—(Inset in Figure 137), are very much more widely distributed than may be supposed. It has been said that they cannot be *sun*-dials because in very many instances the radii or the spaces cannot be assigned in any possible way to the twenty-four hours of the day. But it must be remembered that "Time" has not always been computed as at present; there have been many quite distinct notations of time, and *our* division of the day into twenty-four hours is comparatively modern. The Saxons divided it into "Tides," each of three hours, and their earliest dials—which are semi-circular (Figure 141) mark four tides (day-time). The circular dials marking eight tides (day and night) came later. At a later period these divisions were sub-divided and, still later, further sub-divided until at last they were brought into conformity with the twenty-four hour method. Some persons say "as the sun cannot throw a shadow upward these dials cannot be *sun*-dials," but the reply to this appears to be that having selected the chariot wheel as the shape or form of the sun-dial it was natural to use the complete form even though only the lower half was needed. Apart from that, the complete "wheel" possibly often proved useful in enabling a person to determine the position of the hours at a glance notwithstanding the general absence of figures. But that this was a question of completeness rather than anything else is shewn by the Great Edstone, Great Easton, and Kirkdale dials (Figures 136, 139 and 141). The former although circular has only the lower radii cut, both the latter are semi-circles. It has sometimes been said that certain dials cannot be Saxon because they were obviously made at a later period; but the term "Saxon" refers to the notation, not necessarily to the workmanship. The varying spacing of the lines on Saxon dials has been the cause of much perplexity to those who have failed to notice a much greater variation in modern sun-dials, usually owing to the orientation of the building (or—more correctly—the declination of the dial). Churches are invariably built approximately "East and West," but secular buildings cannot always be placed according to that rule; therefore the modern sun-dials which are found upon private houses, schools, and so on, vary to a much greater extent than do the Saxon dials found upon churches. Although a very large number of Saxon dials still have the tang of the gnomon embedded in the stone, most careful search has failed to discover one with the original gnomon intact — which is not surprising when their age and exposed position is remembered. Because the tang is horizontal many persons believe the only possible gnomon was a horizontal one, and that therefore the dials cannot possibly be *sun*-dials; but this error is probably the outcome of having heard, or read, the erroneous statement, "The gnomon *must* be parallel to the Earth's axis." (The angle or otherwise of the gnomon makes no difference to the possibility of reading time.) Perhaps the

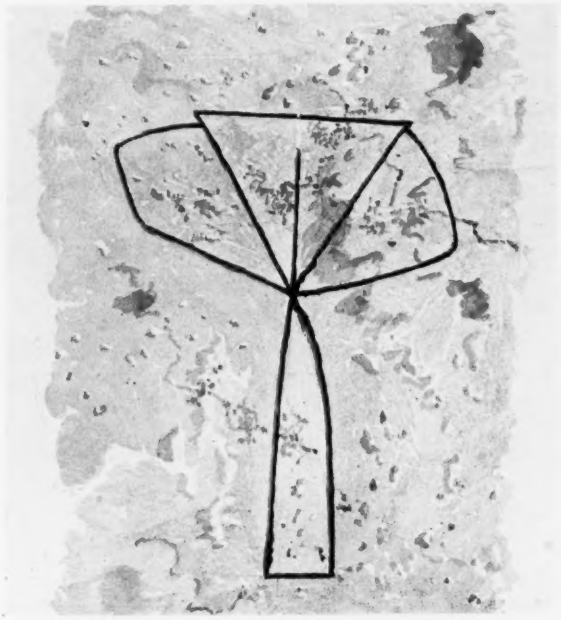

FIGURE 149. Mason's "mark" at Trowse.

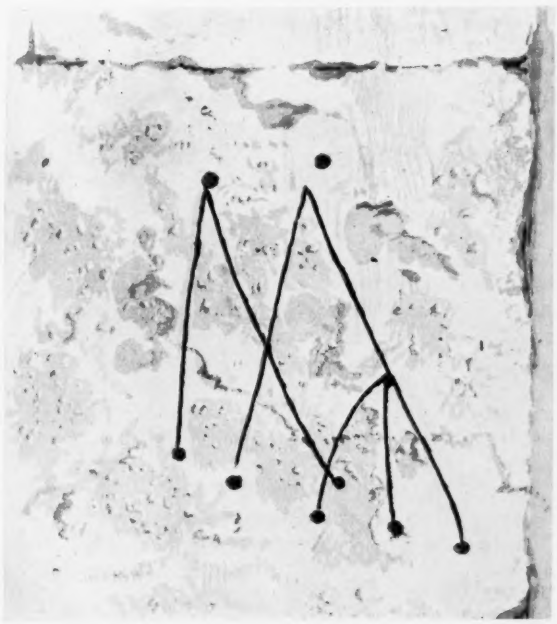

FIGURE 150. Mason's "mark" at Hellington.

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best possible evidence that the Saxon dials *are* sun-dials is afforded by the Great Edstone, Swardeston, Kirkdale (Figures 136, 138, 141), and Market Deeping dials. In the majority of instances one finds simply a *dial, i.e.,* the dial without inscription or figures; but the two former *have* an inscription (indisputably contemporaneous with the dials), and both of the latter have *figures* denoting the hours. In the centre panel of the Kirkdale dial the inscription (translated) tells us, "This is Day's Sunmarker at every Tide," and that (translated) on the Great Edstone dial (a sketch of which was very kindly sent by the Rector) describes it as the "Clock of Travellers." In instances—of which there are many—where the radii cannot be assigned to any known notation of time, ecclesiastical (*e.g.,* the canonical hours) or secular, the explanation will probably be that they are due to the "Reformers."

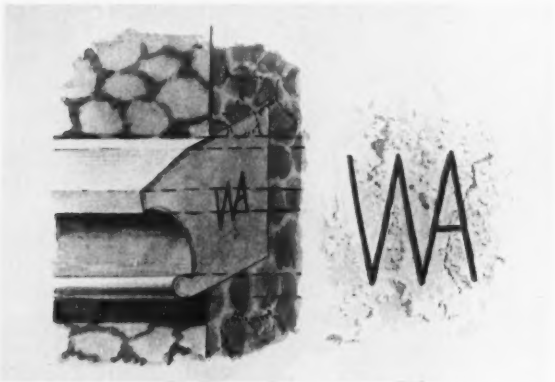


FIGURE 151. The "mark" of a mason living in Norwich.

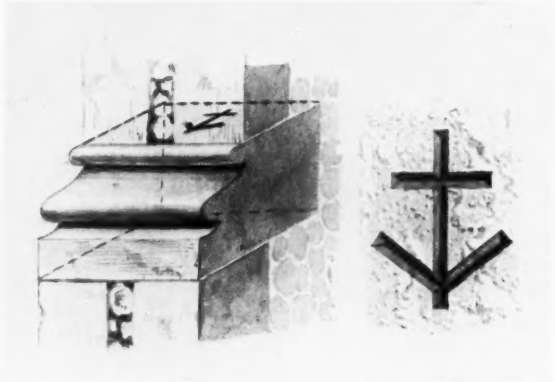


FIGURE 152. Another "mark" of a mason living in Norwich.

The finding of Saxon dials which have no hole (and obviously never had one) for fixing a gnomon has been claimed as convincing proof that they are not *sun*-dials; but Mr. Arthur Bentley's "conjectural method of fixing the gnomon" (Figure 146), which is reproduced by his kind permission, has most effectually explained that difficulty.

It is interesting to notice how easily Figures 142–145 may be mistaken for Figure 140, as all three examples are very much weathered, and a casual observer would probably notice practically no difference. Figure 140 is one of the Tacolneston dials, Figure 142 is a consecration cross (All Saints', Norwich), and Figure 145 is a mason's mark (Claxton).

The term "Orientation" previously referred to is frequently misunderstood. It is very usual to say "Churches are built East and West" but comparatively few persons know that very few are due East, and that there is generally quite sufficient variation to make the adjustment of the markings of a sun-dial necessary. The variation is caused in this way:—The foundations of a church are laid according to the position of the sun on the patronal feast; therefore a church dedicated to, say, St. John the Baptist (June 24th) is not in exactly the same position with regard to East and West as one dedicated to, say, St. Andrew (November 30th)—and this divergence has to be allowed for when marking the lines upon the sun-dial.

Sexton's Wheels (which have been unaccountably confused with Saxon dials) are portable articles, and only two specimens are known to exist—at Long Stratton and Yaxley, both in the diocese of Norwich. They have no connection either in form or use with sun-dials and a very interesting illustrated description of them will be found in "Norfolk Archæology," Vol. IX, 1881.

The authors are greatly indebted to the large number of persons who have not only corresponded but have gone to considerable trouble in making rubbings, sketches, and so on; especially to Mr. R. H. Flood (who lent a very large number of interesting rubbings), and to Mr. Arthur F. C. Bentley (who most kindly made and presented practical models of four primitive sun-dials—set out for the latitude of Horstead, in Norfolk—and whose "conjectural method of fixing the gnomon" helped them out of what undoubtedly proved one of their greatest difficulties).

THE FACE OF THE SKY FOR MAY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Uranus. R.A.	Uranus. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
May 5 ..	2 48·6	N.16·2	18 7·5	S.28·4	1 19·8	N. 5·5	1 46·3	N. 9·5	7 13·5	N.24·0	16 49·6	S.21·6	20 22·6	S.19·9	7 31·8	N.21·2
,, 10 ..	3 7·9	17·6	22 19·7	S.14·7	1 32·3	6·3	2 9·6	11·7	7 25·9	23·6	16 47·4	21·6	20 23·6	20·0	7 32·2	21·2
,, 15 ..	3 27·6	18·8	2 11·6	N.14·6	1 50·7	7·9	2 33·2	13·8	7 38·3	23·1	16 45·1	21·5	20 23·6	20·0	7 32·6	21·2
,, 20 ..	3 47·4	20·0	7 19·6	N.27·4	2 13·1	10·1	2 57·2	15·7	7 50·7	22·6	16 42·5	21·4	20 23·4	20·0	7 33·1	21·2
,, 25 ..	4 7·5	20·9	11 57·0	N. 2·5	2 39·7	12·7	3 21·7	17·5	8 3·1	22·0	16 39·9	21·4	20 23·2	20·0	7 33·7	21·2
,, 30 ..	4 27·8	N.21·8	16 1·6	S.24·2	3 10·8	N.15·7	3 46·6	N.19·2	8 15·4	N.21·3	16 37·2	S.21·3	20 22·8	S.20·0	7 34·3	N.21·2

TABLE 12.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Mars. P	Mars. B	Mars. L	Mars. T	Mars. Q	Mars. q	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	h m	°	"	°	°	°	°	h m	h m
May 5	−23·4	−3·6	309·1	− 1·2	−16·6	+7·6	300·3	4 5·2 *e*	96·2	·39	+6·6	−2·9	323·5	149·8	10 50 *e*	7 52 *m*
,, 10	22·3	3·1	243·0	−20·1	15·0	8·8	252·1	7 23·6 *e*	97·4	·37	6·9	2·9	33·8	181·8	1 14 *m*	4 55 *e*
,, 15	21·0	2·5	176·9	− 17·8	13·3	9·9	203·8	10 42·2 *e*	98·4	·35	7·1	2·9	104·0	213·9	7 0 *e*	4 2 *e*
,, 20	19·6	1·9	110·8	+ 7·8	11·6	11·1	155·4	1 21·1 *m*	99·5	·32	7·4	2·9	174·2	246·0	7 14 *m*	5 13 *m*
,, 25	17·9	1·3	44·6	+21·9	9·9	12·2	107·1	4 39·9 *m*	100·6	·30	7·6	2·9	244·4	278·0	3 10 *e*	2 16 *e*
,, 30	−16·2	−0·7	338·4	+10·2	−8·1	+13·3	58·6	7 58·9 *m*	101·6	·28	+7·9	−2·9	314·6	310·0	1 14 *e*	3 27 *m*

TABLE 13.

m, *e* denote morning, evening respectively. Greenwich Civil Time (day commencing at midnight) is used. P is the position angle of the body's North Pole measured eastward from the North Point of the disc. B, L are the Helio-(planeto-)graphical latitude and longitude of the centre of the disc (N. latitudes +). In the case of Jupiter there are two systems of longitude, the first for the equatorial region, the second for the temperate zones.

T denotes the time of passage of the zero meridian. Intermediate passages for Mars, Jupiter I and II may be found by applying multiples of $24^h\ 39{\cdot}7^m$, $9^h\ 50{\cdot}4^m$, $9^h\ 55{\cdot}6^m$ respectively.

Q, q for Mars are the position angle and amount of the greatest defect of illumination.

THE SUN continues his northward march, but with slackening speed. During May the semi-diameter changes from 15′ 53″·6 to 15′ 47″·8; Sunrise $4^h\ 34^m$ on 1st, $3^h\ 52^m$ on 31st. Sunset $7^h\ 20^m$ on 1st, $8^h\ 3^m$ on 31st. As this is probably the year of minimum, sunspots and prominences are few and small.

MERCURY is a morning star throughout the month; being south of the Sun it is better placed for observers in the southern hemisphere. It is in elongation 26° from Sun, May 13th. The semi-diameter diminishes from 5″ to 3″, the illuminated portion of disc increases from $\frac{1}{4}$ to $\frac{3}{4}$.

VENUS is approaching superior conjunction, and is too near the Sun for convenient observation. Semi-diameter 5″, $\frac{9{\cdot}7}{100}$ of disc illuminated.

THE MOON is full May $1^d\ 10^h\ 19^m$ *m*, L. Quar. $9^d\ 9^h\ 56^m$ *m*, New $16^d\ 10^h\ 14^m$ *e*, F. Quar. $23^d\ 2^h\ 11^m$ *e*, Full $30^d\ 11^h\ 30^m$ *e*. Apogee $7^d\ 8^h$ *e* (semi-diam. 14′ 48″); Perigee $19^d\ 5^h$ *e* (semi-diam. 16′ 24″); Maximum Librations 5° W. April 30^d, 7° N. May 6^d, 6° E. 14^d, 6° S. 20^d, 5° W. 26^d, 6° N. June 3rd. The letters indicate the region of the Moon's limb that is brought into view by libration; E. W. mean the East and West with regard to our sky, not as they would appear to an observer on the Moon. Thus W. is the side towards Mare Crisium.

Date.	Star's Name.	Magnitudes.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1912.			h m		h m	
May 2 ...	BAC 5253	5·4	9 39 *e*	165°	10.25 *e*	248°
,, 3 ...	BAC 5289	5·4	0. 0 *m*	116	1.20 *m*	291
,, 8 ...	BAC 7077	6·2	2. 9 *m*	59	3.28 *m*	272
,, 20 ...	C Geminorum	5·5	7.37 *e*	124	8.33 *e*	272
,, 27 ...	BD—13° 3802...	6·8	11.15 *e*	136	—	—
,, 29 ...	BD—22° 3989...	6 0	9.56 *e*	61	10.42 *e*	350
,, 29 ...	42 Librae	5·0	11.55 *e*	159	0.49 *m**	244
,, 30 ...	Antares...	1·3	8.48 *e*	114	10. 2 *e*	290
,, 30 ...	BAC 5513	6·2	9.54 *e*	99	11.12 *e*	302

TABLE 14. Occultations of stars by the Moon visible at Greenwich.

The asterisk indicates the day following that given in the date column. From New to Full disappearances occur of the Dark limb, from Full to New reappearances. Attention is called to the occultation of Antares on the 30th. It is low down at disappearance, but fairly well placed for reappearance.

XUM

MARS is approaching conjunction; semi-diameter $2\frac{1}{2}''$. It is 2° N. of δ Geminorum on the 5th, 2° N. of Neptune on the 12th, 5° S. of Pollux on the 15th.

JUPITER reaches opposition on June 1st when its equatorial semi-diameter is $22\frac{1}{2}''$, Polar $1\frac{1}{2}''$ less. The configurations of the satellites as seen with an inverting telescope at $0^h\ 30^m$ *m* are:—

Day.	West.	East.	Day.	West.	East.
May 1	42 ○ 13		May 17	4 ○ $\frac{1}{3}$ 2	
,, 2	41 ○ 23		,, 18	$43\frac{1}{2}$ ○	
,, 3	4 ⊙ 12		,, 19	432 ○ 1	
,, 4	$3\frac{1}{3}$ ○	1●	,, 20	$\frac{1}{3}$ ○ 2	1●
,, 5	321 ○ 4		,, 21	14 ○ 32	
,, 6	3 ○ 124		,, 22	2 ○ 143	
,, 7	1 ○ 234		,, 23	12 ○ 34	
,, 8	2 ○ 134		,, 24	○ $\frac{1}{3}$ 24	
,, 9	1 ○ 34	2●	,, 25	31 ⊙ 4	
,, 10	○ 3124		,, 26	32 ○ 14	
,, 11	321 ○ 4		,, 27	3 ○ 24	1●
,, 12	32 ⊙ 4		,, 28	1 ○ 24	3●
,, 13	34 ○ 12		,, 29	2 ○ $\frac{1}{4}$ 3	
,, 14	41 ○ $\frac{3}{4}$		,, 30	$4\frac{1}{4}$ ○ 3	
,, 15	42 ○ 13		,, 31	4 ○ $\frac{1}{3}$ 2	
,, 16	412 ○ 3				

Satellite phenomena visible at Greenwich, $1^d\ 11^h\ 45^m e$ II. Oc. R.; $2^d\ 10^h\ 43^m e$ III. Sh. E., $11^h\ 27^m e$ III. Tr. I.; $3^d\ 1^h\ 19^m m$ III. Tr. E., $2^h\ 31^m m$ I. Sh. I., $3^h\ 12^m m$ I. Tr. I.; $3^d\ 11^h\ 53^m\ 45^s e$ I. Ec. D.; $4^d\ 2^h\ 43^m m$ I. Oc. R.; $4^d\ 11^h\ 13^m e$ I. Sh. E., $11^h\ 50^m e$ I. Tr. E.; $7^d\ 4^h\ 7^m m$ II. Sh. I.; $8^d\ 10^h\ 20^m\ 29^s e$ II. Ec. D.; $9^d\ 2^h\ 3^m m$ II. Oc. R.; $10^d\ 0^h\ 36^m m$ III. Sh. I., $2^h\ 41^m m$, III. Sh. E, $2^h\ 49^m m$ III. Tr. I.; $11^d\ 1^h\ 47^m\ 24^s$ I. Ec. D.; $11^d\ 10^h\ 53^m\ e$ I. Sh. I., $11^h\ 22^m e$ I. Tr. I.; $12^d\ 1^h\ 7^m m$ I. Sh. E., $1^h\ 35^m m$ I. Tr. E.; $12^d\ 10^h\ 54^m e$ I. Oc. R.; $16^d\ 0^h\ 55^m\ 51^s m$, II. Ec. D.; $17^d\ 10^h\ 39^m e$ II. Sh. E., $11^h\ 19^m e$ II. Tr. E.; $18^d\ 3^h\ 41^m\ 8^s m$ I. Ec. D.; $19^d\ 6^h\ 47^m m$ I. Sh. I. $1^h\ 7^m m$ I. Tr. I., $3^h\ 1^m m$, I. Sh. E., $3^h\ 19^m m$ I. Tr. E.; $19^d\ 10^h\ 9^m\ 33^s e$ I. Ec. D.; $20^d\ 0^h\ 38^m m$ I. Oc. R.; $20^d\ 9^h\ 29^m e$ I. Sh. E., $9^h\ 46^m e$ I. Tr. E., $9^h\ 52^m e$ III. Oc. R; $23^d\ 3^h\ 31^m\ 30^s m$ II. Ec. D.; $24^d\ 10^h\ 33^m e$ II. Sh. I., $10^h\ 56^m e$ II. Tr. I.; $25^d\ 1^h\ 13^m m$ II. Sh. E., $1^h\ 33^m m$ II. Tr. E.; $26^d\ 2^h\ 41^m m$ I. Sh I., $2^h\ 51^m m$, I. Tr. I.; $27^d\ 0^h\ 3^m\ 24^s m$ I. Ec. D., $2^h\ 22^m m$ I. Oc. R.; $27^d\ 9^h\ 10^m e$ I. Sh. I., $9^h\ 17^m e$ I. Tr. I., $10^h\ 48^m\ 39^s e$ III. Ec. D., $11^h\ 23^m e$ I. Sh. E., $11^h\ 30^m e$ I. Tr. E.; $28^d\ 1^h\ 10^m m$ III. Oc. R.; $28^d\ 8^h\ 48^m e$ I. Oc. R.

SATURN is invisible, being in conjunction with the Sun on the 14th.

URANUS is a morning star, better placed for southern observers; semi-diameter 2″.

NEPTUNE is an evening star, semi-diameter 1″; 2° south of Mars on 12th.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
Mar. to May	263°	+ 62°	Rather swift.
Apr. to May	193	+ 58	Slow, yellow.
,, to May	296	0	Swift, streaks.
May 1 to 6 ...	338	− 2	Aquarids, swift, streaks.
,, 7 ...	246	+ 3	Slow, bright.
,, 11 to 18	231	+ 27	Slow, small.
,, 30 to Aug.	333	+ 28	Swift, streaks.
,, —June ...	280	+ 32	Swift.
,, —July ...	252	− 21	Slow, trains.
,, 18 to 31	245	+ 29	Swift, white.

CLUSTERS AND NEBULAE.

Name.	R.A.	Dec.	Remarks.
M. 53	$13^h\ 8^m$	N 18°·7	Fine cluster of small stars.
M. 63	13 11	N 42 ·6	Oval nebula with nucleus.
M. 51	13 26	N 47 ·7	The famous spiral nebula.
M. 3	13 38	N 28 ·9	Splendid cluster.
⊞ I. 70	14 24	S 5 ·5	Cluster of very faint stars.

DOUBLE STARS.—The limits of R.A. are 13^h to 15^h.

Star.	Right Ascension. h. m.	Declination.	Magnitudes.	Angle. N. to E.	Distance.	Colours, etc.
θ Virginis	13 5	S 5°·0	4, 9	343°	7″	White violet.
42 Comae	13 6	N 18 ·0	6, 6	199	$\frac{1}{2}$	Orange.
ξ Urs. Maj.	13 20	N 55 ·4	2, 4	150	15	Yellow.
25 Can. Ven. ...	13 33	N 36 ·7	5, 8	130	1	White, blue.
K Bootis	14 10	N 52 ·2	4, 6	236	13	Yellow, blue.
Σ 1825	14 12	N 20 ·5	7, 8	173	4	Just North of Arcturus.
Σ 1831	14 13	N 57 ·1	6, 9	140	6	White, ash.
Σ 1835	14 19	N 8 ·8	5, 7	192	6	Greenish, bluish.
		The smaller star is a very close double $\frac{1}{4}''$ apart.				
ϕ Virginis	14 23	S 1 ·9	5, 9	110	4	Yellow, blue.
ζ Bootis	14 37	N 14 ·1	$3\frac{1}{2}$, 4	147	$\frac{1}{2}$	White.
ϵ Bootis	14 41	N 27 ·4	3, 6	329	3	Deep yellow, blue.
		Known as Pulcherrima from the beauty of the colours.				
ξ Bootis	14 47	N 19 ·4	5, 6	180	3	Yellow, purple.
39 Bootis	14 47	N 49 ·0	6, 6	44	3	White, purple.

NOTE.—"The Face of the Sky," we would remind our readers, is published a month in advance so that when it reaches Subscribers and their friends abroad it is in time to be of use to them.

CORRESPONDENCE.

DIVIDING ANGLES INTO THREE EQUAL PARTS.

To the Editors of "KNOWLEDGE."

SIRS,—Your article last month on the above subject I at first thought to be a claim to have solved the outstanding classical problem in Pure Geometry "To trisect a given rectilineal angle," a problem which has interested many of us and wasted many an hour. The approximation of Mr. Bingley's reminds me of one of my attempts which may be sufficiently interesting to record. All your geometrical readers (not their shape), will know that by joining the bisection of a side of a parallelogram to one of the opposite angles, the diagonal is trisected. I fondly hoped that it might be possible to trisect an arc in somewhat the same way with curved if not with straight lines. If we include a right angle in a circle with its centre at the angular point and join through the bisection of one side with the extremity of the diameter of which the other side is a part, the 90° arc is not trisected though there is a suggestion that the line may cut the circle at the apex of the equilateral triangle standing on the other side (see Figure 153), but the angle $\tan^{-1}\cdot\frac{4}{3}$ is formed.

This is not an encouraging start, but on applying this to smaller angles good approximations well within the draughtsman's error are reached (see Figure 154).

'Let A B C be the given angle. Describe the circle A C with centre B. Produce C B to the circumference at D. Bisect A B at E. Join D E and produce to the circumference at F. The arc A C is *approximately* trisected at F. The word in italics is unfortunate but necessary.

If we try an angle of 120° it is actually bisected, whereas one of 90°, as we have found, comes within 7° of the proper place. Calculation shows that at 60° the error has fallen to 1° 47′; for 45° it is 43′ only, then it rapidly decreases and at 30° it is less than 11′, which is already negligible; the two-thirds angle always being slightly too small.

Mr. Bingley's method, I find, gives precisely the same results, his E J, E K, lines corresponding to my D F though obtained by a more elaborate construction. He, however, bisects his angle first, so that when I speak of an angle 30° his would be 60°.

To prove the relationship of the two methods let us take a

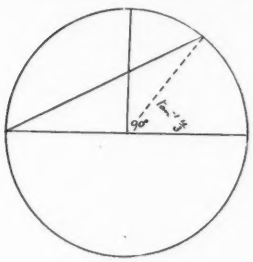


FIGURE 153.

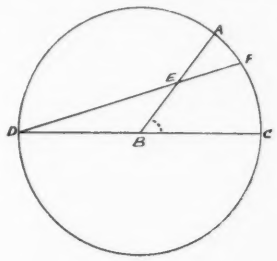


FIGURE 154.

part of his figure, but with a larger angle and a complete circle (see Figure 155 where A D, E C, and G D are bisected).

Take the centre of rectangular co-ordinates at A, the axis of X, A C, and the co-ordinates of D (a, b) where $a^2 + b^2 = 1$.

The co-ordinates of the points will be:—

A, (0, 0); C, (1, 0); D, (a, b);

$$E, \left(\frac{a}{2}, \frac{b}{2}\right); \quad G, \left(\frac{a+2}{4}, \frac{b}{4}\right); \quad I, \left(\frac{5a+2}{8}, \frac{5b}{8}\right)$$

Equation to E I:—

$$\frac{y - \frac{5b}{8}}{\frac{b}{2} - \frac{5b}{8}} = \frac{x - \frac{5a+2}{8}}{\frac{a}{2} - \frac{5a+2}{8}}$$

or

$$\frac{8y - 5b}{-b} = \frac{8x - 5a - 2}{-a - 2}$$

$$\therefore y = \frac{b}{a+2}(x+1).$$

This and the equation to the circle $x^2 + y^2 = 1$, are obviously both satisfied by $y = 0$, $x = -1$.

Therefore, K E when produced cuts the circle at *Z*, and the two constructions produce the same results.

In the above investigation the co-ordinates a, b, do not necessarily refer to the circle; the $a^2 + b^2 = 1$, is not used; showing that the point D may be anywhere and K E always cuts the circle at *Z*! (see Figure 156). Of course the approximation is not

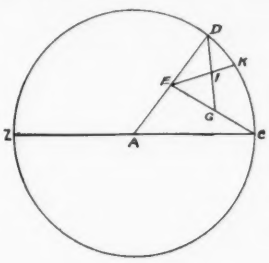


FIGURE 155.

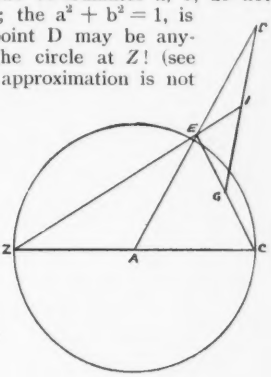


FIGURE 156.

obtained unless D is taken on the circumference. There is no particular mystery about the process finding the circle at last, for C is of necessity on the circle.

The construction of Figure 156 doubles a straight line, C A, by a system of bisections—a rather curious result.

HASTINGS. H. F. CHESHIRE, B.Sc., F.I.C.

THE TRISECTION OF ANGLES.

To the Editors of "KNOWLEDGE."

SIRS,—I am much obliged for the interest that your correspondents, Messrs. Thomson and "Computer," have taken in this matter, originated by my little article in your November, 1911, issue, and for their corrections and remarks thereon. I only intended the method to apply to small angles of 45° or less, as then stated, as it is not applicable to larger angles. With the means at my disposal, which are, unfortunately, very primitive, I could not detect any error, but I quite accept the corrections, of course, and am only sorry that the method turns out to be inaccurate, or, in other words, not a method at all. As to angles of exactly 45°, 90°, 135° and 180°, surely these are mathematically divisible by a much simpler method than Mr. Thomson's No. 2, *viz.*: the angles 45°, 90° and 180° by that of 60°, and the angle of 135° by that of 90°? I have always so treated them, and should be glad to be shewn any correction that they require.

185, ALBION ROAD, N. CHAS. S. BINGLEY.

THE FLIGHT OF BIRDS.

To the Editors of "KNOWLEDGE."

SIRS,—The methods of birds in maintaining or rather recovering energy of position during flapless or soaring flight is very easy of observation in the plains of India during the beginning of the hot weather, and the following notes may be of interest to some of your readers less favourably placed as regards opportunities for watching them. The two conditions required, namely, ascending currents of air and a plentiful supply of large soaring birds, are both present. At the beginning of the hot weather, before the more regular winds set in, the air near

XUM

the surface of the ground is intensely heated during the middle hours of the day, the atmosphere as a whole being more or less at rest. This unstable state of a heated lower layer gives rise to numerous minute whirlwinds, locally known as "Dust Devils," varying in size from a few feet to perhaps a hundred yards in diameter, and in duration from about ten seconds to as many minutes or longer. Their appearance on first forming is that of a whirling column of dust, mixed with leaves, straws, and so on, which, after continuing for some time, gradually lose their sharp outline and appear to be more or less dissipated, but the consequent uprush of air can be traced for long afterwards by the cloud of dead leaves hovering far above the surface of the earth. The action is, of course, similar to the formation of waterspouts at sea.

Soaring birds, such as Vultures, Kites and Storks, are common; indeed, it is of very rare occurrence that the sky can be searched for two minutes without discovering at least one Vulture. These, however, are usually at such an elevation that they are useless for the present observations.

A low-flying bird is required, and one is chosen flying across country, perhaps two or three hundred feet above the ground and straight as the proverbial crow.

Observed with good glasses, the wings and tail are seen to be practically motionless as a whole, but with a constant adjustment of the plane angles.

The loss of elevation as it proceeds is clearly noticeable, and if it cannot find an external source of energy it must flap or come to the ground. It need not proceed far, however, before encountering a dust devil uprush, on meeting which the straight flight is changed to a circular one, on which it mounts, still without flapping, to a limit either at which the uprush of air is no longer strong enough, if the dust devil be small, or at which the Vulture chooses to start off again on its straight flight.

It should be understood that the birds do not circle on a dust devil in active operation, as the motion is then extremely violent, but after breaking, as noted above, the vertical current becomes suitable for the birds' purpose. Numerous dead leaves may occasionally be noticed hovering amongst the circling birds.

At times the dust devil movement does not begin by the intense motion as previously stated, but a gentle uprush vortex motion sets in, which gradually drifts across the country. These are frequently occupied by twenty or thirty Vultures, which continue to circle as long as visible. The upward current is detected by the radially inward draught felt when the movement passes near the observer.

In the early morning or late afternoon, when the dust devils do not occur, the Vultures invariably proceed by alternate flapping and soaring flight.

The extent of the bearing power of these upward movements of the air is evident from the phenomena of dead leaves dropping out of the still evening sky, as late as can be observed up to and after sunset, the last dust devil having broken up some two or three hours previously.

MELBOURNE. S. TULLOCH.

THE SUN'S PATH IN SPACE.

To the Editors of "KNOWLEDGE."

SIRS,—The direction of the Sun's path in Space has been calculated with some degree of certainty by observations of "Star Drift." Could not its path be ascertained with a greater amount of accuracy by calculations of the differing positions of the centre of gravity of the Solar System, which must change to some very slight but still appreciable degree, with the relative changes in the positions of the planets?

If, for instance, when the larger planets are in conjunction, or in opposition, or at their perihelion, or at their aphelion, a sufficient number of calculations were made of the consequent varying positions of the centre of gravity of the Solar System in Space, some definite resultant might be found, shewing the direction in which it is travelling.

G. R. GIBBS.

BOURNEMOUTH.

ASTRONOMY.

To the Editors of "KNOWLEDGE."

SIRS,—I believe I am right in saying that while some account for the origin of the moon by saying that it at one time formed part of the earth,—an offshoot from the earth, and so on,—others explain it as being an old planet.

The reasoning for this latter explanation seems to be that a body goes through the following processes: First, the sun; second, the sun cooled and become a planet, fit for the abode of living creatures; third, the planet cooled and become a moon, a dead world.

To take as an example the sun and the earth. The supposition would be that the earth was previously a sun, but had now cooled and become a planet. As the sun gets cooler, so, naturally, will the earth, until the latter eventually reaches the phase of a moon.

It seems to be rather on these lines that Mr. Proctor bases his theory of Jupiter's moons being inhabited (*vide* "Expanse of Heaven"), Jupiter being put forward as a sort of sun, with his moons really planets (Jupiter in this way might be regarded as illustrating the half-way stage in the evolution of a sun to a planet fit for living creatures).

At a lecture I attended not long ago the lecturer happened to mention the theory of the moon being an offshoot from the earth, and at the close of the lecture I mentioned the other theory (just described), and asked him which of the two was the more universally accepted. He seemed never to have heard of the second theory at all.

Can you tell me which of these two theories finds most support from astronomers of to-day?

"INQUIRER."

CATFORD, S.E.

ON THE ROTATION OF VENUS.

To the Editors of "KNOWLEDGE."

SIRS,—I write this letter in answer to the doubts expressed by your correspondent, Mr. Harrison, in the hope that my reply may be of general interest to your readers.

Mr. Harrison first contrasts the conclusions of Belopolsky and Slipher as to their spectroscopic evidence.

It is to me amply evident that in this matter Slipher's conclusions are the stronger, founded as they are on photographs taken on a more favourable opportunity and with a more powerful spectroscope than that used by Belopolsky. It is a striking fact that Slipher's results indicate no rotation at all—for the final mean radial velocities deduced are conflicting in sign, and either practically equal to or less than the probable errors of observation. The evidence is therefore negative.

Referring to the Lowell Observatory Bulletins Nos. 3 and 4, I find the following statements:—

"A rotation period of twenty-four hours would in the case of Venus imply an inclination of 15′ to the normal in the planetary lines. The probable errors of determination of the inclination of the lines are, in the case of Venus, somewhat less than 1′ in the final result."

"When Mars' spectrum was measured to test the method—an inclination of 6′·6 was found—indicating a period of revolution within an hour of the known one." (These quotations are not verbatim but condensed.)

It is then apparent that had Venus any such period the latter could be determined with more than double the accuracy possible in the case of Mars. It is thus clear that Venus' period is much longer than that of the Earth.

Now for positive evidence as to how much longer the period may be, visual observations are our only resource; and thanks to the purifying influence of modern research, that source is now reliable. I have myself been able to corroborate the markings seen by Schiaparelli, Lowell and others, and I am convinced not only of their reality on the planet, but of their fixity with regard to the terminator. They indicate without question that the planet turns always the same face to the Sun.

The observations of Schroeter and De Vico, quoted by Mr. Harrison, were interpreted by them to indicate a period about

equal to that of the Earth. It is absurd to suppose that they could also support such a period and also a period half as long again. To do this all the planetary markings would have to be in two places at once—in his eye and his telescope perhaps they appeared to be—but on the planet never. If the markings charted by the older observers were real they should be easily visible in the vastly better telescopes of the present day. In ordinary air—the better the telescope the more immaculate the planet appears. It is only under very favourable climatic conditions that the observer can be assured of their reality. They are harder to see than the canals of Mars. It is therefore foolish to quote the early observers, whose evidence in the light of modern research is thus proved to be valueless, for they never saw canals on Mars. Nevertheless to them is owing the credit of opening the question. The radial markings discovered by Lowell are just those to be expected on a planet which is like a cryophorus: a planet which has one side permanently heated—and consequently having an inward and upward fountain circulation of atmosphere.

Again, G. H. Darwin's "Tidal Theory" suggests the reason for and the probability of Venus always turning the same face to the Sun—which probability is increased by the likelihood that Venus never revolved as fast as the earth did at the time of the birth of the Moon. For Venus has no large satellite. Hence she was never disrupted by the tidal action of the Sun operating in conjunction with centrifugal force, due to very rapid rotation. Yet, since solar tides on Venus are much more potent than on the earth, this disruption is *a priori* the more likely. If, then, Venus never rotated as fast as the Earth once did, she would the more quickly have been stopped by these same tides; and having no large satellite, there is no other attractive force to oppose that of the Sun. To sum up, every piece of reliable evidence we have been able to adduce points to a rotation period of two hundred and twenty-five days. There is not a shred of conflicting testimony. There seems to me to be no reason whatever for hesitating further to accept the indicated conclusion that the orbital and rotational periods of Venus are identical.

JAMES H. WORTHINGTON.

LOWELL OBSERVATORY,
FLAGSTAFF, A.T.

ORNITHOLOGY.

To the Editors of "KNOWLEDGE."

SIRS,—In "KNOWLEDGE" for December, I noticed that a correspondent wrote regarding the starling as a mimic; I write an article headed—"Does the starling relieve sheep of ticks?"

On grounds where sheep are grazing, especially if such grounds be somewhat boggy, starlings are seen perched upon the backs of sheep. Starlings are said to visit sheep in order to feed on the ticks which infest the sheep. After close, patient watching I could never see the starlings pick into the wool on the back of the sheep for ticks. I am inclined to think that the starlings visit sheep because they find their backs comfortable and handy. Then these birds seem to be of a very friendly nature to animals they are accustomed to feed amongst. An article in "Nature Notes" of the *Scotsman* recently showed the social nature of this bird in captivity with a cat, "Starling and kitten." The bird was seen perched upon the back of the cat. Sometimes the starling was found sleeping in this position for half-an-hour.

EDGAR GRANT.

EDINBURGH.

THE VELOCITY OF LIGHT.

To the Editors of "KNOWLEDGE."

SIRS,—I am a little disappointed to find that Colonel Gibbs was not facetious in his suggestion as to the velocity of light.

May I point out that his error is based on his fundamental fallacy that the eye "is not capable of seeing anything that passes across its field of vision in less than a tenth of a second." This may or may not be true of some objects—such as a bullet—but it is absurd to suppose it true of a luminous object.

CHARLES E. BENHAM.

COLCHESTER.

THUNDERSTORMS.

To the Editors of "KNOWLEDGE."

SIRS,—Mr. Chamberlayne asks in your issue of January last:—"Inasmuch as the world is round and thunderstorms like everything else have a beginning, it follows that the first flash of lightning in any storm must be directly over somebody's head. How is it then that we cannot meet with anyone who remembers anything of the sort?"

My estimate based on observations here would be that out of one hundred thunderstorms one breaks almost exactly overhead. A remarkable case occurred here about six weeks ago; remarkable because the discharge came to the ground, which is unusual at the very beginning of a storm; and it was so heavy that it injured telephones.

TRANSVAAL OBSERVATORY, JOHANNESBURG. R. T. A. INNES.

To the Editors of "KNOWLEDGE."

SIRS,—Mr. Chamberlayne's letter on "Thunderstorms" recalls an instance which I may offer as an answer to his question. One afternoon in the late spring of 1892, at Denver, Colorado, the sky clouded slowly, whilst the temperature remained rather high. At six o'clock the heavens were entirely covered, and half an hour later, without any preliminary electrical display, a brilliant flash of lightning rent the clouds, and was followed instantly by a heavy peal of thunder. In a few minutes rain began to fall. The storm, with its attendant electricity, lasted nearly an hour before moving away.

This is the only instance of the kind that I have particularly remarked. Here, on the coast of California, thunderstorms, even of a mild type, are infrequent, so there is little opportunity to make observations of their phenomena. Storms in the mountains are sometimes visible here, at a distance of from fifteen to twenty-five miles, and, as these are always local in character, the "first flash direcly overhead" must often have been observed in them.

CHARLES C. CONROY.

LOS ANGELES,
CALIFORNIA.

NOTICES.

THE HORNIMAN MUSEUM.—The new Library at the Horniman Museum, which was recently opened to the public, will now be available on week days throughout the year, from 11.0 a.m.to 9.0 p.m., and on Sundays from 3.0 to 9.0 p.m. It will, however, be closed on Christmas Day, Good Friday and Bank Holidays.

FLAME CARBONS.—Messrs. William Guiper and Company, have introduced improvements in their flame carbons, with the result that their business in this department, as in others, shows considerable increase upon that of 1910, or indeed of any year since they took over the business of Messrs. Paterson and Company.

XUM

THE KNOWLEDGE OF THE LIVING NAPOLEON DURING THE LAST PHASE [1815-1821].

By A. M. BROADLEY,

Author of "Napoleon in Caricature."

SINCE the beginning of the present year two books have been published which ought to throw some new light on the personality of Napoleon during the last five years of his eventful life. If the student is somewhat disappointed at the paucity of information of this particular kind contained in the superbly-printed pages of Monsieur Frédéric Masson's monumental work "Napoléon à St. Hélène," he will find some consolation in the lively pages of Mr. G. L. de St. M. Watson's "A Polish Exile with Napoleon"—a work based mainly on painstaking research in historical ground which may fairly be described as unbroken.

In the concluding volume of his great biography of the younger Pitt, entitled "Pitt and Napoleon Miscellanies," will be found a very interesting account of an interview with Napoleon which took place at Elba on the evening of January 26th, 1815. Four days previously two English travellers, Major I. H. Vivian and his companion, Mr. Wildman, had arrived at Porto Ferrajo from Leghorn. The interview they sought for was arranged through Count Bertrand, and at the appointed time they were, "without any form or ceremony whatever," ushered into the presence of the Great Man. Twenty-four years later Major Vivian printed, for private circulation only, the narrative now republished by Dr. Rose. We are told the room of modest dimensions in which Napoleon received his English guests was fitted up with old yellow furniture brought from the palace of his sister at Piombino. The conversation lasted from 8.30 to 9.45 p.m., and Major Vivian had a unique opportunity of studying the personal appearance of Napoleon as it was five months before Waterloo. He writes:—

"We stood, during the whole time, I may say almost *nez à nez*, for I had my back against the table, and he had advanced close to me, looking full in my face. . . . . He had on a green coat, cut off in front, faced with the same colour and trimmed with red at the skirts, and wore the stars of two orders. Under his left arm he held his hat, and in his hand a plain snuff-box, from which he every now and then took a pinch; but as he occasionally sneezed, it appeared to me that he was not addicted to snuff-taking. His hair was without powder and quite straight; his shape, inclined to corpulence."

FIGURE 157.
Napoleon on the "Bellerophon," after Eastlake's picture, 1815.

We have no present concern with the return from Elba, the Reign of a Hundred Days, or Waterloo. Suffice it to say that at sunrise on Saturday, July 15th (only eleven days short of six months since the interview with Vivian and Wildman in the "yellow" drawing-room of the Imperial Residence at Elba), Napoleon, wearing the uniform of a colonel of the *Chasseurs de la Garde*, went on board the "Bellerophon." Exactly a week later the ship arrived at Plymouth. On the following day (Sunday, July 23rd), the ship moved to Torbay, where she remained until the following Wednesday (July 26th). On that day the "Bellerophon" returned to Plymouth, and there on July 31st Napoleon learned his fate. Early in the afternoon of August 7th (Monday), the Emperor went on board the "Northumberland" at Starpoint. The same day she set sail for St. Helena. During the days spent at Torbay and Plymouth, Napoleon was seen by many thousands of persons. It is only quite lately that the last of those who looked on "Little Boney" face to face from the crowded boats cruising round the "Bellerophon" in July, 1815, expired. Twenty years ago a score of surviving witnesses were still able to testify to the approximate correctness of the familiar picture by Sir C. L. Eastlake, P.R.A., now reproduced as the first of the series of last phase portraits. (See Figure 157.)

Eastlake was a native of Plymouth, where he was born on November 17th, 1793. He was studying the masterpieces of the Louvre, when the news of Napoleon's landing caused him to quit Paris on March 19th, the same day as Louis the Well-Beloved took to flight. When the "Bellerophon" arrived in Plymouth Sound, Eastlake promptly postponed all the work he had on hand, and, "hovering round the ship" in a boat, took a series of rapid sketches of Napoleon as he stood in the gangway, from which he elaborated a small full-length portrait of the Emperor, and another life-size. The latter was subsequently exhibited in London. The fine mezzotint executed from it by C. Turner, is familiar to most collectors, but when used as an illustration by the present writer, an art critic declared that the picture represented Napoleon at Malmaison, and that the rolled-up hammocks and other accessories belonged to a garden instead of a ship! The Turner mezzotint, of which an exceptionally fine example in the second state is now in the possession of Mr. Henry Parker, of Whitcombe Street, bears the following inscription:—

"Napoleon Boneparte as he presented himself at the gangway of His Majesty's Ship "Bellerophon," in Plymouth Sound, in the month of August, 1815. To His Royal Highness the Prince Regent this print, as commemorating the result of the persevering resistance of Great Britain to the ambition of Napoleon, and as exhibiting one of the immediate and most important consequences of the Victory of Waterloo, Is, with His Royal Highness's permission, humbly and respectfully dedicated by His Royal Highness's faithful, devoted servant, Charles Lock Eastlake. London. Published August 26, 1816, by C. Turner, 50, Warren Street, Fitzroy Square."

Mr. Denzil Ibbetson, of the Commissariat Department, sailed in the "Northumberland," and between Monday, August 7th, when the ship left the Sound, and Tuesday, October 17th, when Napoleon disembarked at Jamestown, executed the various portraits described in the current issue of *The Century Magazine*, the majority of which were unknown and unidentified until discovered by the present writer. It was most probably from one of these that Mr. Williams prepared the print issued by T. Patser, on January 14th, 1816, now given as an illustration. (See Figure 158.) This was certainly one of the first portraits of Napoleon published in Europe after his arrival at St. Helena. The figure of the Emperor bears a strong resemblance to that introduced into Major Stewart's view of the "Briars" which appeared in the last issue of "KNOWLEDGE." (See page 100.)

FIGURE 158.

Napoleon on the "Northumberland," from an aquatint by Williams, published by Thomas Parker, January 14th, 1816, presumably from one of Denzil Ibbetson's sketches.

FIGURE 159.

Napoleon. Portrait forming the frontispiece to Barnes's "Tour through the Island of St. Helena."

Early in 1904, a letter addressed by Sir Stamford Raffles to Mr. Sholto V. Hare, came into the possession of the writer. It is dated "Off St. Helena, May 20th, 1816," and covers no less than twenty-four quarto sheets. It gives a most detailed account of an interview which our Minister in Java had had with Napoleon at Longwood, a day or two before. The visit of Sir Stamford Raffles is not mentioned by M. Albert Schuermans in his "Itinéraire Général." He notes that it was on May 16th, Sir Hudson Lowe communicated to the Emperor the Convention of Paris, of August 2nd. On May 17th, Napoleon was working on the events of 18 Brumaire and the Egyptian Campaign. On May 19th he was making notes on the events of 1815.

The personality of Napoleon in May, 1816, did not impress Sir Stamford Raffles as favourably as it did Major Vivian

and Mr. Wildman, in January, 1815. He says:—

"Our first view of him was from the window across the lawn, where we beheld, not what we expected, an interesting, animated and martial figure, but a heavy clumsy man, moving with a very awkward gait, and reminding us of a citizen lounging in the tea gardens about London on a Sunday afternoon. He was dressed in a large, but plain, cocked hat, a dark green hunting coat, with a star, etc., on the left breast, white kerseymere breeches and white silk stockings."

FIGURE 160.
Napoleon. From a sketch made in April, 1820.

In another part of the letter he writes:—

"Bonaparte must either be very different in his present appearance and demeanour to what he once was, or we have all been in a great measure deceived. In person he is more like old Wardemaat, of Batavia, than any man I can name. This resemblance struck us all. To be sure, he has not quite so large a belly, but in other points he does not fall short in size. His face is square, his colour sallow, and his eyes jaundiced without reflecting one ray of light. His visage generally was not unlike that of a Brazilian Portuguese. Though still deficient in animation, his manner was abrupt, rude and authoritative, and the most ungentlemanly that I ever witnessed. While speaking he took snuff or seemed to take it, for there was none in his box, and altogether treated us in the same manner as in his worst humour he was wont to do."

Captain John Barnes's "Tour through the Island of St. Helena" was published in London a year after the Raffles visit. The coloured frontispiece "Napoleon Buonaparte on the Island of St. Helena" is now reproduced. It must, for obvious reasons, have been engraved by R. B. Peake from a sketch of earlier date, and does not in any case show the deterioration spoken of so unflatteringly by Sir Stamford Raffles, who declared he came to Longwood with a predisposition in favour of the illustrious exile. There is no description of Napoleon to be found in Captain Barnes's commonplace text, but amongst the subscribers to the work are Lieut.-Col. Dodgin, C.B., Lieut. Dodgin and Ensign Dodgin, all of the 66th Regiment. Lieutenant (afterwards Captain) Dodgin, as Mr. Watson points out, is responsible for the portrait of Napoleon executed in 1820, now given. (See Figure 160.) Another of Barnes's subscribers was Mr. Denzil Ibbetson.

The only uniform Napoleon ever put on at St. Helena was that of the Chasseurs de la Garde, the green coat with red facings, white breeches and top-boots, shewn in the Barnes frontispiece; but on November 28th, 1815, he dropped the uniform (only to be resumed on special occasions, such as his move to Longwood on December 10th, 1815), and put on a cut-away tail-coat, brown or green, with white breeches and silk hose, a small hat with tricolour cockade and the *plaque* and ribbon of the Legion of Honour. The green coat was an old hunting

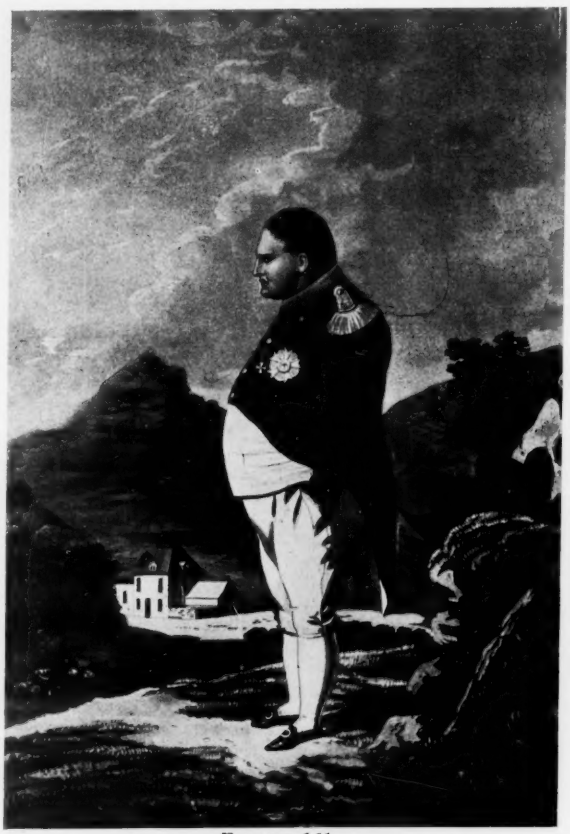


FIGURE 161.
Napoleon as portrayed by Captain Dodgin of the 66th Regiment in 1820.

costume of the Fontainebleau period and was turned by Santini when it got very shabby. The cockade was dropped in June, 1817. After Santini's departure, tailors from Jamestown and the British regiments made various articles of dress for Longwood, but nothing specially for Napoleon, except the "planter's" costume. It is to Mr. Watson that we are indebted for a knowledge of Captain Nicholls's journal, in which, with "sartorial correctitude," he describes the grotesque appearance of the General (the use of the word Emperor was strictly forbidden), in "his nankeen jacket, waiscoat and *trowsers* and a straw hat." The Duke of Wellington is credited with having invented trowsers about 1810. The Bath militiamen threatened a mutiny in defence of the doomed knee-breeches, and Oxford and Cambridge undergraduates who adopted the new garments incurred grave censure on the part of the outraged authorities. We see the "planter's" garb in the horrible portrait entitled "Napoleon at St. Helena in the second year of Cancer of the Stomach" issued by Standridge & Co., London, early in 1821. Below the cynical artist or publisher has placed the lines :—

"I never had for *abstract* fame much passion,
But would much rather have a sound digestion
Than Buonaparte's cancer—could I dash on
Through fifty victories to shame or fame,
Without a stomach—what were a great name?"

FIGURE 162.

Anonymous caricature portrait, June 5th, 1820.

Mr. Watson says that this dress was adopted in 1820, but it does not appear, at any rate in its entirety, in the portrait entitled "*Fleshy* ci-devant *Bony*—Drawn from the life at Longwood, June 5th,

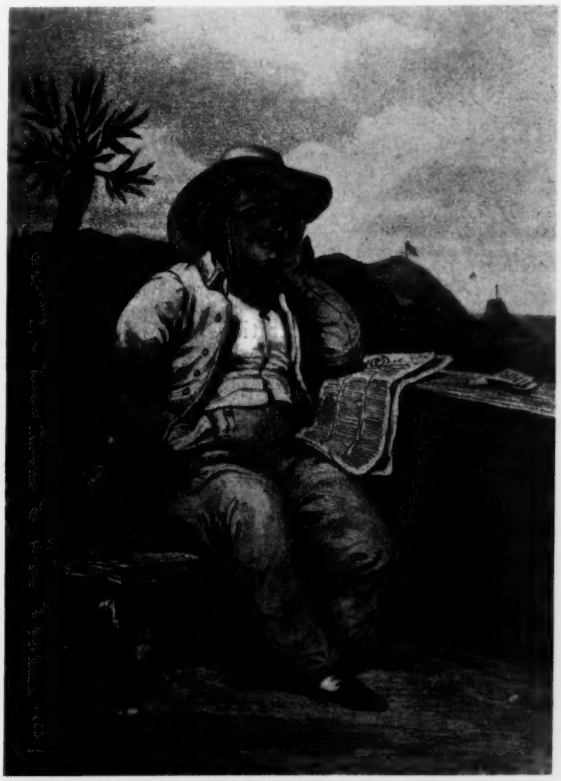


FIGURE 163.

Napoleon. Caricature portrait early in 1821.

1820." (See Figure 162.) It is altogether absent in the Dodgin portrait of the same year (see Figure 161), but it is clearly shewn in a third 1820 portrait in the collection of the writer. (See Figure 163.) Archembault replaced Santini as tailor, and Captain Lutyens in his journal speaks of a tailor of the 66th regiment being hard at work with him. Mr. Watson informed the writer that "the only overcoat the Emperor used was a little grey one, as on the field of battle. The 'cloak of Marengo' was religiously kept by Marchand, and used only for the last function after death. On the opening of the coffin in 1840, it was found in fair condition, as well as the Chasseur's uniform. The epaulets had tarnished, but the central head of the Legion of Honour *plaque* was still bright. The boots had split and the toes protruded." This last is clearly seen in the illustration, Figure 104, in the last issue of this journal.

When Napoleon landed at St. Helena at the end of 1815 he was already sallow and corpulent. No great change occurred in 1816 or 1817, but later he put on more flesh, and we have the pronounced double chin and flaccid face reflected in the Dodgin portrait

now given. The gardening exercise failed to combat the constant increase of adiposity which called forth Doveton's coarse, if truthful, epithet "plump as a Chinese pig." He suffered much from bad teeth and swollen gums, and early in 1820 his eyesight began to fail. From this time onwards he could not read without immediate fatigue and strain. During his last illness he lost some of the fat which had given him the protuberant abdomen which Dodgin made the most of, but at the post-mortem dissection Antommarchi had to cut through three-quarters of an inch of subcutaneous fat before reaching the viscera. Immediately after death the fat under the skin of the face, as Ibbetson noticed, dried up and the cheeks sank a little. When friends and foes stood round his death-bed on May 6th, the dead Napoleon had once again the finely-chiselled features of the First Consul. With one accord they said: "How beautiful!"

CUTTING DOWN A CHIMNEY LIKE A TREE.

By FRANK C. PERKINS.

THE accompanying illustration, Figure 164, shows a chimney ready to be thrown like a tree, while Figure 165, shows the stack when falling to the ground. This stack was ten feet square at the base, and a hundred feet high, and was built of common brick, lined with fire brick, and topped out with a cast iron cap.

It will be seen that the method of throwing this stack was quite similar to the cutting down of a large tree. Brickwork on the south side of the stack was cut out, extreme care being taken to make the cut symmetrical on each side of the centre line of the stack.

The first illustration (see Figure 164), shows quite clearly this method of cutting, which was continued until the weight of the stack began to crush the brickwork at the edge of the cutting, and as soon as this occurred the stack, of course, fell to the south.

It is stated that, so accurately was the work done, the fallen stack lay exactly parallel with the sidewalk, as was intended. The outer shell of the stack crushed downward, while the inner lining maintained its original shape until the falling stack struck the ground.

It is of interest to note that the stack was originally part of the Brush electric plant in Cleveland, Ohio, the site of which is now occupied by some of the factories of the National Electric Lamp Association. It was used in connection with the japanning process, and the stack was removed in order to make room for a large new incandescent lamp factory.

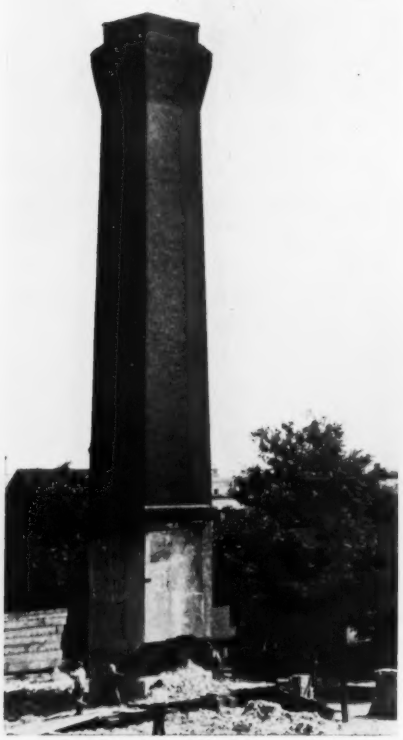


FIGURE 164.

FIGURE 165.

THE SWEDISH SYSTEM OF EDUCATIONAL AND MEDICAL GYMNASTICS.

By RHODA ANSTEY,

Principal of Anstey College for Physical Training and Hygiene, Erdington.

THE attention now being given to hygiene and physical culture is a very hopeful sign of the times. Mr. Gladstone once said that all the time and money spent on training the body and the voice paid a better interest than any other investment. A sound body is needful to all; it is well that English people are waking to this fact, and that there is such a wide-spread desire to improve the nation's physique.

The Swedish system of physical training which is found to produce such excellent results in the hands of trained teachers, represents the lifework of Per Henrik Ling, a man of remarkable genius, born in Sweden in the year 1776.

The fundamental principle of Ling's System is

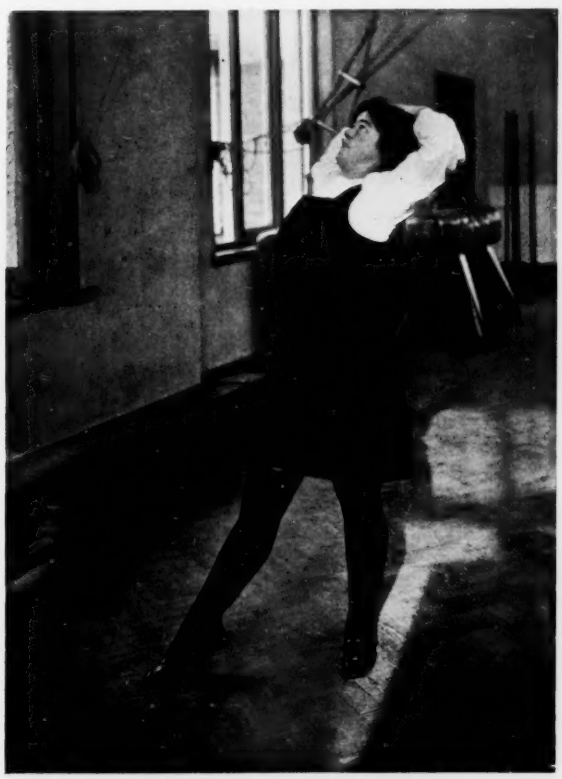


FIGURE 166. Arch Flexion.

the harmonious development of mind and body, the mind to be dominant, the body obedient.

Ling taught that right thinking and a right direction of physical strength was of primary importance. The following episode in his life, narrated by an eye witness, is given by Westerblad, in his book on the Life and Work of Ling. "Ling once delivered a lecture in which he said that great strength, even the greatest, if badly used is nothing when compared to a little strength well used. At these words an auditor exclaimed, "Your theory is excellent, and I realise its correctness; will you oblige us by giving a practical proof of it?"

FIGURE 167. Heaving Movement.

"At this request Ling hesitated for an instant. But after a moment's consideration he answered, 'I will prove the truth of my words.' 'Will you bring me a long lance?' he continued, addressing those present. They brought him what he asked for. 'We'll make an experiment with this lance,' he said. 'Which of you are the strongest? Six of you come forward, please. Seize the end of the lance, please.' Ling went on 'You are six young men and you have at your disposal a capital lance with a head as sharp as the blade of a sword. Nevertheless, I bid you attack me, and to run me through with the lance without mercy—if you are able to do it, you see. I promise not to budge from the spot. When I give the word of command, you may advance. The

XUM

lance-head directly towards my breast! Well, are you ready?'

"At this moment Ling was really imposing. He

FIGURE 168. Balancing.

positively increased in height, while his eyes beamed with fire and life. He gave the word 'Go' and the six young men rushed forward. Ling did not move from the spot, but fixed his eyes sharply on the lance-head and lifted his hand towards his breast. Just as the lance-head was at a distance of a few inches he parried the thrust with his little finger, and the lance-head entered the wall at his side. A volley of applause rang through the hall." The truth of this story is vouched for by a pupil of his who was present.

Ling was well versed in the scientific knowledge of his day, but he also possessed a profound intuitive understanding of the laws of the human organism. His system is based on knowledge of anatomical, physiological and psychological laws which were not fully known to science at that time. After a hundred years his theories have received their justification, both from scientific research and practical experience.

Ling's system was evolved upon a therapeutic basis. He was first attracted to the idea of systematic exercise by observing the curative effect on himself. But he was not satisfied to regard these exercises as a mere vehicle for physical health, he maintained that gymnastics had a higher significance, and placed them among the arts and sciences. He gave out these new ideas and insisted on the importance of a two-fold national regeneration, a regeneration of Swedish manhood, and of Swedish poetry. The remedies he proposed in ardent speeches were systematic gymnastic exercises, and a revival of old Scandinavian poetry. His theories met with scornful opposition at first; the daily papers commented on them in no flattering terms, designating him as a "charlatan" and a "gymnastic harlequin." People trifled with his ideas and laughed at his innovations, but the innovations increased instead of diminishing, while he fought for his ideals with intense enthusiasm and power.

Ling believed that if gymnastic training could become a national aim and a national ambition, it would be possible to produce health, strength and beauty in youth, to conserve them through adult life, and prolong them during old age. Also that it was possible by systematic exercises to correct many imperfections in the body and cause certain functional derangements to yield to this most natural method of cure, provided each exercise had a definite physiological aim and produced a definite physiological result. He then conceived the idea that an extensive, graduated series of movements

FIGURE 169. Shoulder Movement.

could be devised, suitable for every stage, from weakness up to the greatest strength, adaptable alike to the requirements of little children, to girls as well

as boys, to women as well as men, and again to the use of those who even in advanced years might wish to derive the benefits conferred by exercises. The fulfilment of this idea became the object of his life. In time all opposition was broken down, and he succeeded in founding a Gymnastic Institute in Stockholm, with Government aid, and he became its first Director.

For many years Ling worked patiently and earnestly, studying natural science; making himself conversant with the human body in all conditions of health and disease, of weakness and of strength; learning and realizing its possibilities and its limitations. He studied the Greek art of gymnastics, and the different forms of athletics and gymnastics of modern times. He evolved great principles, was entirely guided by them, and rejected all exercises which did not come up to their high standard. With a stern hand he put aside all movements for *effect*, and weeded out the injurious elements of competition and excitement. He made close and practical experiment of the effects of different kinds of exercises on the physique in various states, and finally produced an elaborate series of pure, simple and beautiful movements, each having its own aim and producing its own result. Then, with a master hand, he drew

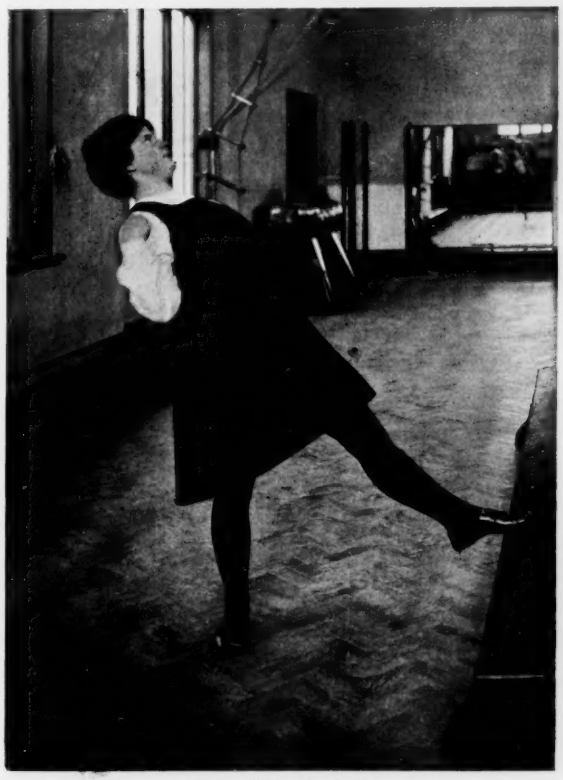


FIGURE 170. Abdominal Movements.

up into form and completed his work—a work which has since obtained a unique position as a classical system of physical education.

Ling's system is divided into four branches, which intertwine to some extent:—

Educational.—Comprising both apparatus and free

FIGURE 171. Trunk Flexion.

exercises for schools and classes, designed to develop the entire physique harmoniously, and to quicken and cultivate the mental faculties.

Medical.—Used only for curative and preventive purposes, extensively supplemented by massage.

Military.—For the full training of soldiers. The Swedish system has recently been introduced at Aldershot, and into the English Navy.

Aesthetic.—To express by pose and gesture every kind of emotion. Swedish gymnastics is a *system*, and in this fact lies much of its value. The human body being a highly organised system, demands an organised method of culture. The kernel of the Swedish system is (1) the arrangement of the exercises in each lesson; (2) the progression from the easy to the more difficult, lesson by lesson, as muscle and nerve powers increase. In the educational branch there are nine classes of movements. In every lesson, whether elementary or advanced, the same plan is used. It is found that gymnastic training built on this plan gives the best results, *e.g.*, most progress is made in the shortest time by this method, one exercise preparing for, and leading up to another. The movements follow each other in the correct order, one or more from each class being

XUM

FIGURE 172. Jumping.

introduced. This is the plan originally evolved by Ling, and used by all properly trained teachers.

The nine classes of movements are arranged in the following order:

1. INTRODUCTORY EXERCISES.—These consist of marching; movements of legs and arms; easy trunk and head movements; simple exercises used to gain muscular control and to prepare for those which follow. They quicken the circulation; prepare the body for special work; give the teacher an opportunity to correct faults of posture, and bring teacher and pupils into touch with each other, and both into the spirit of the work.

2. ARCH FLEXIONS (see Figure 166) consist of backward bendings of the trunk in the dorsal region, movements which have a special effect on the thorax; they contract the muscles of the back, straighten the dorsal spine, elevate the chest and correct its posture. The chest capacity is enlarged, and respiration increased by reaction. The immediate effect is to draw more air into the lungs and, therefore, to supply more oxygen to the muscles. This is absolutely necessary as a preparation for more difficult movements which follow—for without this increase of oxygen they either could not be well done or might cause strain. There is permanent enlargement of the thorax and elevation of all the organs contained in the thorax and abdomen. This produces

FIGURE 173. Alighting from a Jump.

a smarter and more upright carriage, a graceful walk and increased power of the organs of digestion.

3. HEAVING MOVEMENTS exercise and develop the arm and shoulder muscles. They include all suspending (see Figure 167) and climbing exercises. They also prevent and correct faulty positions of the spine.

By constantly practising these two kinds of movements the chest enlarges both lengthwise and in breadth. It will be seen that the greatest attention is given to the development of the chest, for in order to be strong we must breathe deeply and well. Good breathing power means health, strength, endurance and longevity. This is why the Swedish method discards all movements which compress the chest.

4. BALANCE MOVEMENTS (see Figure 168) come after Heave movements because they equalise the circulation which has been directed to the chest. The pupil gets out of breath from climbing, and so on, and the heart beats more quickly: so we give here a movement which has a calming effect and lessens the heart beat.

Balance movements are general in effect, they do not need much muscular effort, but they require concentration of mind. Their special effect is on the nervous system, which they train and strengthen. Balance movements cultivate co-ordination, give consciousness of power, and a reposeful bearing; they teach correct poise, and enable the body to move gracefully and easily. After doing the balance movement the pupil is again ready for more specific work.

5. SHOULDER (see Figure 169), BACK, AND NECK MOVEMENTS strengthen the muscles of the back and neck, thereby giving the head and upper part of the body a more noble poise. They develop the brain, and increase skill of hand. They are also used to correct round shoulders and flat chest.

6. ABDOMINAL MOVEMENTS (see Figure 170) affect the digestion and assimilation of food. They have a good effect on both mind and body through improved nutrition. They develop the waist muscles, and thus give a trimness to the figure. They are used to correct hollow back and protruding abdomen.

7. LATERAL TRUNK MOVEMENTS (see Figure 171) consist of trunk rotation and sideway flexions. They accentuate the effect of the abdominal movements. They quicken the circulation of the large veins of the trunk and promote the activity of the liver. They strengthen the waist muscles and develop "Nature's corset." Nature has given us muscles with which to support the body in an upright position. Exercise strengthens these muscles, corsets weaken them.

8. JUMPING (see Figures 172 and 173) AND VAULTING develop courage, presence of mind and co-ordination. These exercises develop spring, and from their widespread effect and bracing nature exert an exhilarating influence on mind and body.

FIGURE 174. Inspiration.

FIGURE 175. Expiration.

Respiratory Exercises.

XUM

They induce quickness of thought and action. As they need more skill than any of the preceding they are placed at the end of the lesson, when control of body has been acquired.

9. RESPIRATORY EXERCISES (see Figures 174 and 175). Consist of deep inspirations and expirations for the purpose of increasing the supply of oxygen to the system. They are generally accompanied by some simple arm movements which open the chest. They lessen fatigue and give a sense of repose.

Thus every part of the body is scientifically trained and strengthened. The organs of respiration, circulation and digestion receive more attention than the muscular development, so that these storehouses of vitality may be replenished and the brain, nerves and muscles supplied with healthy nutriment.

The movements are executed at word of command in order to prevent mechanical work and involuntary imitation. It is an essential principle that each exercise should be completely and correctly carried out at the teacher's command, as the best results are obtained even in a simple movement by the concentration of the will on the exercise. Style and precision of movement and progress in details are aimed at rather than feats of strength.

The importance of having fully trained teachers as exponents of the Swedish system cannot be too much emphasised; much harm is being done by the ignorant and uninitiated, who attempt to teach so-called "Swedish Drill" after having learnt a few exercises. It must be remembered that while suitable exercises, properly performed, can and do correct faulty postures, unsuitable and even suitable ones incorrectly performed produce, and exaggerate, the very postures and deformities of the body for which they are meant to be corrective.

Unless a teacher is both trained and observant more harm than good is likely to be done by teaching gymnastics. As Dr. Shrubsell says:—"No one would dream of placing a teacher who had never learned mathematics in charge of a mathematical class, where the worst that could happen would be failure to acquire knowledge, a purely negative result; whereas often untrained teachers are set to put a class through gymnastic exercises, with the grave risk of producing a permanent, positive result in the direction of bad carriage and even bodily deformity. Two years is none too long in which to learn both the principles of the subject and their application. Slight knowledge is almost more dangerous than none at all."

Swedish gymnastics should constitute a part of the ordinary school work, and a place should be given for daily lessons in the timetable. Being less recreative, and presenting a corrective element, they are not intended to take the place of games. They make considerable calls on the mental as well as the bodily activities, and to produce the best effects should be taken during morning school and not relegated to the last period of the afternoon.

It is instructive to notice that during the thirty years the Swedish system has been in general use in Scandinavian schools, the average stature and weight of the children have shown a marked increase.

[NOTE.—We had the pleasure of going down to the Anstey College and seeing for ourselves the most interesting and successful work of the students there. Birmingham is only two hours' journey from Euston on the London and North-Western Railway, and a local train carries one on to Chester Road, Erdington, which is practically in the suburbs of the city.—EDS.]

THE STUDY OF PRIMITIVE MUSIC.

DR. C. S. MYERS gave a lecture on "Primitive Music" at the Royal Anthropological Institute on Tuesday, March 19th, when the President, Mr. Alfred P. Maudslay, was in the chair.

In this paper the chief objects and methods of studying the music of primitive peoples were described, illustrated by examples from Borneo (Sarawak), Torres Straits (Murray Islanders) and Ceylon (Veddas), the music of which Dr. Myers had personally investigated. Many of the songs were exhibited by means of the phonograph,—an instrument, the importance of which, even to the most musically-gifted ethnologist working "in the field," was strongly emphasized. The structure and details of other songs were indicated by various lantern slides in which (i) the music was reduced to our own notation; (ii) the nature and frequency of the various intervals employed were demonstrated, the intervals being expressed in ratios of vibration frequencies or in "cents," *i.e.*, hundredth parts of our tempered semitone, and (iii) the various scales deduced from the songs were shown. Detailed descriptions were given of the *technique* of analysing phonographic records and of the graphic method introduced by Dr. Myers for recording "in the field" the occasionally baffling rhythms, met with especially in the drum accompaniments to primitive music. The music of the Murray Islanders and of the Todas was analysed to show (i) the wide difference even between such very simple forms of music belonging to two distant peoples; (ii) the different lines of musical development traceable within different communities; (iii) the great importance, alike for ethnology and for musical history, of studying the process of diffusion of the various styles of music, and also of musical instruments, in regard to their form, their intervals and their absolute pitch.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

I HAVE decided to use my column this month to give an explanation of the Harvard system of classification of star-spectra, which is now in general use. As spectra are often quoted simply by their letters in this classification, and as the full description in *Harvard Annals*, Vol. XXVIII, is probably not readily accessible to many of our readers, it seems likely that it will be convenient to give a summary of it here.

The main classes of spectra are denoted by the letters O, B, A, F, G, K, M, N, which originally followed each other in alphabetical order (in the Draper Catalogue), but have now been put into the order which is conjectured to be the chronological order of their life-history. The fact, recently discovered by Professor Campbell, that average radial velocities increase as we pass from the beginning to the end of this set of letters, is a distinct confirmation of the theory that it is a true chronological sequence. Besides the above eight letters, P and Q are used, the former for gaseous nebulae, the latter for peculiar spectra having bright lines. Small letters following the capital ones, as Oa, Mb, and so on, indicate sub-divisions of main classes. Where two capitals are used with a numeral between, as B1A, B3A, B5A, the meaning is that the type is intermediate between B and A, and one-tenth, three-tenths, five-tenths respectively of the interval from the former to the latter type.

We now proceed to the description of the types. The letter O in general corresponds to Secchi's Fifth Type.

Oa.—There are no very bright stars of this type. The spectra consist of bright bands on a faint continuous background. Two of the bright bands are hydrogen ones, 4101·8 = Hδ, 4340·7 = Hγ. A fainter one at 4471·8 appears to be helium. There is a broad conspicuous band at 4633.

Ob.—There are no very bright stars of this type. Spectrum similar in general character to Oa, but positions and intensities of the bands differ. Several hydrogen lines bright, including Hϵ, Hδ, Hγ, Hβ; no helium lines seen. An intensely bright band has centre at 4688.

Oc.—No very bright stars of this type. The bands are much narrower than in Ob. Hδ, Hγ, Hβ, 4471·8 (helium) and 4688 are again bright.

Od.—Typical star ζ Puppis. All lines are dark except 4633 and 4688, which are bright. The dark lines are narrow. Hydrogen lines dark. Only four other dark lines.

Oe.—Typical star, 29 Canis Maj.; like Od, but far more dark lines.

Oe5B.—Typical stars, τ Can. Maj., ι and θ^1 Orionis. No bright bands. Resemble Oe in hydrogen spectrum, B in helium spectrum. K (calcium) sharply defined.

B.—This is sometimes known as the "Helium" or "Orion" type. Typical stars, ϵ, ζ, δ Orionis. Helium lines more conspicuous than hydrogen ones.

B1A.—Type, β Centauri. More faint lines than in B. Helium lines intense, including D_3.

B2A.—Type, γ Orionis. The helium lines attain their maximum intensity in this class.

B3A.—Types, α Pavonis, π^4 Orionis. Diminution in strength of "Orion" lines.

B5A.—Type, η Tauri (Alcyone). Helium still present, but less conspicuous; hydrogen, calcium, and so on, more conspicuous.

B8A.—Type, γ Gruis. Hydrogen lines still increasing in intensity, and are hazy; twelve "Orion" lines still seen. The solar lines seen in Class A now begin to appear.

B9A.—Type, λ Centauri. Spectrum like A class, with addition of helium.

A (Sirian stars).—Types, Sirius and Vega. Secchi's First Type. Hydrogen lines attain their maximum strength in this and in the next class. Calcium fairly conspicuous, and there are ninety-three solar lines.

A2F.—Type, ι Centauri. Calcium and solar lines are stronger than in last.

A3F.—Type, τ^3 Eridani. Calcium more intense; solar lines more numerous and more intense.

A5F.—Type, α Pictoris. Hydrogen begins to weaken, solar lines continue to strengthen. All lines somewhat hazy.

F.—Type, α Carinae. This class is intermediate between Secchi's first and second types. Hydrogen only half as intense as in A. Ultra-violet spectrum strong. Three hundred and twenty-six solar lines present.

F2G.—Type, π Sagittarii. The G band in the spectrum grows stronger.

F5G.—Type, Procyon. Hydrogen, though only half as intense as in Sirius, is still two or three times as intense as in Sun, while solar lines are fainter and fewer than in Sun.

F8G.—Type, α Fornacis. Resembles following class, except that hydrogen is twice as intense.

G (solar stars).—Secchi's second type. Type Capella. Hydrogen one-fifth as intense as in Sirius. The calcium H,K lines, and the band G are the most conspicuous features.

G5K.—Types, α Reticuli and β Corvi. Hydrogen still grows weaker, and absorption at violet end begins.

K.—Intermediate between Secchi's second and third types. Types α Phoenicis and ϵ Scorpii. Hydrogen one-twelfth as intense as in Sirius. The K line of calcium attains its maximum intensity in this and the next class. There are brightish bands whose limits are 4470 to 4525, 4614 to 4648 in this and preceding class. Arcturus belongs to this class; its spectrum resembles that of a sunspot, so that it is probably much more spotted than the Sun.

K2M.—Type, υ Librae. Like following class in intensities of solar lines and absorption at violet end. But the G band is still continuous as in Class K.

K5M.—Type, Aldebaran. Like Secchi's Third Type. Hydrogen lines one-twentieth as intense as in Sirius, and are inconspicuous among solar lines. The spectrum beyond K too faint to photograph. H,K are conspicuous. The G band is broken up into lines with bright intervals. There are the same brightish bands as in Class K and some others.

Ma.—Types, Betelgeux and γ Hydri. This is Secchi's Third Type. Spectrum banded. There are now well marked bands from 4762 to 4954, and 4954 to 5168, which were faintly seen in K5M. "The edges 4762, 4954, 5168 are brighter than the adjacent continuous spectrum, and the change in intensity from these edges towards the end of greater wavelength is abrupt." There are bright bands, 4470 to 4525, 4556 to 4586, 4657 to 4668. Hydrogen lines similar to Aldebaran. The H,K bands are barely seen. The lines that formed the band G in Classes G to K are now well separated.

Antares is of Class Ma except that hydrogen lines Hβ, Hγ, Hδ are stronger, and Hη, Hζ are present as in Class A. Betelgeux has also stronger hydrogen lines than the normal Ma star.

Mb.—Typical stars, γ Crucis, σ Librae. The abrupt change of light from the edges of the bands towards the end of the spectrum of greater wave-length is more marked than in Ma. Numerous bands brighter than adjacent portions of the spectrum are present. Hydrogen even fainter than Ma, and is only one-thirtieth as intense as in Sirius. Line 4227 reaches its maximum intensity in this class.

Md.—This class resembles Mb, except that Hδ, Hγ, Hβ (hydrogen lines) are bright. The lines of the band G are even less conspicuous than in Class Mb. o Ceti (Mira) is of this class.

N.—This corresponds to Secchi's Fourth Type. It consists of small red stars with banded spectra, the bands being sharply defined at the red end and fading away gradually at the blue end (the opposite to the Third Type). The bands are due to carbon and cyanogen; those of the Third Type have been identified by Fowler with titanium oxide.

XUM

It will be remembered that (as Mr. Eddington recently pointed out) the M stars are intrinsically faint, having strongly absorbing atmospheres; consequently, they cannot be seen at a distance, which is the reason why the Sun's nearer neighbours contain an apparently undue proportion of M stars: they are probably really as common in the more distant parts of space, but too faint for us to see. Conversely the B stars are all very distant, and are probably actually rare in space, but being of great intrinsic brilliance they are seen at immense distances, and so appear in exaggerated numbers in our catalogues. The Sirian type of spectrum of Galactic stars would also be explained by stars of the solar type being invisible at such a great distance.

A NEW STAR.—A new star of the fourth magnitude was discovered at Kiel on March 13th. It is stated to be near Theta Geminorum (the same region where Professor Turner's Nova appeared in March, 1903).

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

POTASSIUM IN PLANTS.—Some interesting results bearing upon the localisation and function of the element potassium in plants have recently been published by Weevers (*Rec. Trav. Néerland.*, VIII., 1911), who made numerous tests by means of Macallum's method for the detection of potassium—the precipitation of potassium-cobalt-nitrite and the conversion of this into the black sulphide of cobalt by treatment with ammonium sulphide.

Weevers found potassium in the tissues of all the plants he examined, covering a wide range, excepting in the blue-green algae (Cyanophyceae) which gave negative results. In no case, however, was potassium to be found in the nucleus, even when abundant in the protoplasm of the cells. Even more surprising, in view of the statements of previous writers, was the entire absence of this element from chlorophyll and from the chromatophores themselves. The greater portion of the potassium was found in the cell-sap vacuoles. In every case the potassium was present in a form soluble in water, and it could be extracted by means of water or dilute alcohol, but was insoluble in ether. In the flowering-plants, this element is most abundant in the ground-tissue (parenchyma), especially in the growing-points and in reserve-food organs. It is also present in the living parenchyma of the wood and bark of trees, and particularly so in the growing-layer (cambium) and in the medullary rays, which appear to serve as storeplaces of potassium for the growth of new shoots.

As to the functions of potassium, Weevers concludes from his observations that this element plays little or no part in the process of carbon assimilation, but is probably concerned in the building-up of protoplasm at the growing-points and in growing tissues generally. In the leaves, it probably helps in the synthesis and also in the breaking-down of proteins.

BIOLOGY OF LICHENS.—An interesting paper by Tobler on the mode of nutrition of lichens was noted some time ago in these columns ("KNOWLEDGE," 1911, page 276). The same writer (*Jahrb. für wiss. Bot.*, 1911) has since published a longer paper—the first instalment of what promises to be an important series of researches—in which he deals with the relation of two so-called "lichen parasites," both belonging to the Peziza family of fungi, to (1) the lichen host itself, to (2) the alga component of the lichen, and to (3) the substratum on which the lichen grows.

The fungus *Phacopsis vulpina* grows on the lichen *Evernia vulpina*, an alpine species. Tobler sectioned the fungus and lichen together in paraffin, and traced the course of the *Phacopsis* hyphae in the lichen thallus. These threads reach the enclosed alga cells and grow closely around these. Where the *Phacopsis* is best developed on the lichen, the alga cells are entirely absent; on other regions the algae are surrounded singly or in groups by the *Phacopsis* threads; in other places the hyphae of both *Phacopsis* and the lichen-fungus are found entwining the algae. Hence the *Phacopsis* threads can in time reach the algae in certain areas of the lichen thallus and displace the threads of the lichen-fungus itself. The algae apparently multiply more rapidly for some time after the *Phacopsis* threads reach them, but they finally disappear entirely where these threads are most profusely developed. The *Phacopsis* threads then spread laterally until large portions of the *Evernia* cortex are cut off from the central tissue (medulla) and eventually die, the invading threads then penetrating into the dead cortex and also into the medulla of the lichen. Tobler concludes that the *Phacopsis* is at first a "parasymbiont," living in partnership with the lichen and later becomes parasitic.

The second parasite investigated, *Karschia destructans*, grows on the thallus of *Chaenotheca chrysocephala*, a bark-inhabiting lichen with thin crustaceous thallus. The *Karschia* penetrates into and through the lichen thallus and into the bark itself, on its way entwining and destroying alga cells and displacing and destroying the hyphae of the lichen. Finally, however, the *Karschia* threads enter the bark and then produces its spore-fruits. Hence *Karschia* is successively a parasymbiont, a parasite, and finally a saprophyte.

From his study of these two fungi, out of about four hundred known to grow on lichens, Tobler concludes that there is no sharp distinction between parasites, parasymbionts, and saprophytes among these lichen-infesting fungi, since a single species may exist in all three conditions during its life history. He also claims that his researches break down the supposed sharp boundary between lichens and fungi, and his interesting observations certainly appear to support the view that the biological distinction between lichen-fungi and other fungi cannot serve any longer to maintain the lichens as a separate group of plants. That is to say, followed to their logical conclusion, Tobler's results lead us to the view that the fungus alone constitutes the lichen.

THE BUCKWHEAT SEED.—In many text-books the seed of Buckwheat, so commonly used as a type for germination in elementary botanical teaching, is said to contain perisperm, *i.e.*, nutritive tissue derived from the nucellus tissue lying outside of the embryo-sac and within the integument of the ovule, and this character has been regarded as an indication of affinity between the buckwheat family (Polygonaceae) and the Pepper family (Piperaceae). Stevens (*Bot. Gaz.*, 1912) has made a careful study of the development and structure of the Buckwheat seed, and finds that it contains no perisperm at all. The early development of the embryo agrees closely with that of the familiar and often-figured Shepherd's Purse (*Capsella*), and accompanying the growth of the embryo there is rapid development of endosperm from the contents of the embryo-sac. The nucellus is at an early stage present as a thin, but actively-growing layer, just within the integument, but as the seed matures this incipient perisperm is obliterated and in the ripe seed it is represented only by crushed remains of cells.

ANTS AND PLANTS.—An interesting paper on this subject has recently been published by Ridley (*Ann. Bot.*), who, as director of the botanical gardens at Singapore, has had exceptional facilities for the study of the myrmecophilous plants of the eastern Tropics. The cases of symbiosis between ants and plants dealt with in this paper fall into three categories.

Many such plants (*e.g.*, *Dischidia rafflesiana* and several Rattans) afford shelter to ants, either within the leaves and flowers or in special hollowed-out organs such as tubular stems or thorns, but the ants get no food from the plant, nor do they appear to benefit the latter, except that in a few cases the ants may bring about pollination when they nestle in and about the flowers, *e.g.*, in *Goniothalamus ridleyi*.

In a second class of myrmecophilous plants there appears to be a relationship, which is mutually advantageous, between many epiphytic ferns and orchids, whose roots afford shelter, and the ants, which in making their nests bring up large quantities of soil and heap it round the base of the plants, *e.g.*,

XUM

Thamnopteris nidus-avis, *Platycerium biforme*, and a considerable number of orchids.

A third class of two small trees, *Macaranga triloba* and *M. griffithiana*, whose hollow stems are pierced and tenanted by ants. These trees have persistent stipules which have glands secreting waxy granules, these being gathered and used as food by the ants. In return for this food and shelter, the ants protect the trees from the attacks of larvae.

ALCOHOLIC FERMENTATION.—Some interesting results have recently been obtained from further work upon the fermentation of sugars by means of yeast. Harden and Norris (*Proc. Roy. Soc.*, B 82) have found that many yeasts that do not ferment the sugar galactose acquire the property of doing so after being cultivated for a time on a medium containing this sugar. They also find that the juice expressed from such a yeast is capable of fermenting galactose, and that the addition of phosphates to the fermentation mixture causes an acceleration of fermentation similar to that observed in mixtures of glucose, fructose, or mannose and yeast juice on the addition of phosphates. In each case, the phosphate is present in the form of an organic compound, from which it is not precipitated by magnesium citrate. Small quantities of sodium arsenite also accelerated fermentation.

As to the nature of the compound formed when a phosphate is added to a fermenting mixture of yeast juice and sugar, different workers have held that (1) the compound is a hexose phosphate containing two phosphoric acid residues; (2) it contains only one phosphoric acid residue, since the osazone obtained from it has only one such residue; (3) it is a triose phosphate. In a recent paper dealing with the mechanism of fermentation, Young (*Biochem. Zeitschr.*, 1911) brings forward evidence to show that the compound is a hexose phosphate with two acid residues, this contention being based largely on the composition of the barium salt of the compound and on the behaviour of its osazone.

Neuberg and Tir (*Biochem. Zeitschr.*, 1911) have greatly extended our knowledge of the action of yeasts upon substances other than sugars. The chief substances which are fermented in this way, with the evolution of carbon dioxide, are the common plant acids occurring in fruit juices, also various components or products of the yeast-cell, *e.g.*, fatty acids, glycerine, and lecithin.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

BACTERIAL DECOMPOSITION OF ARSENIC COMPOUNDS.—Arsenic is usually regarded as a powerful antiseptic agent—so much so that it will preserve organic tissues from undergoing decomposition for many years. Thus, in the case of the arsenic-eaters of Styria the system becomes so saturated with the drug that when the graveyards are opened the bodies of those who had acquired the arsenic habit may be distinguished by their almost perfect state of preservation. There is also evidence to show that arsenic-eaters are particularly immune from infectious diseases.

It is, therefore, surprising to find that certain bacteria can not only live in a strong solution of sodium arsenite, but can also effect its oxidation. This remarkable phenomenon has been discovered by Mr. A. V. Fuller, and its practical importance is emphasised in a circular published by the U.S. Department of Agriculture, Bureau of Animal Industry. (No. 182, November 9th, 1911.)

It was found that arsenical dipping fluids used for washing sheep showed an apparent loss of arsenic after standing for some time in the vats. Experiments proved that this was not due to purely chemical reactions, but was caused by a spontaneous oxidation of the sodium arsenite to sodium arsenate, which escaped detection in the method of estimation employed. The oxidation was shown to be brought about by micro-organisms, which have not yet been isolated or identified. So rapidly did it take place under favourable conditions as to temperature, nature of nutrient substances present, and so on, that in some experiments the arsenic had been almost completely oxidised in the course of a few weeks. Thus, for example, a sample of dipping fluid which contained sodium arsenite in a proportion corresponding to 0·236 per cent. of arsenic trioxide was mixed with suitable nutrient media and inoculated with sheep dip in which the oxidising process had begun. The flasks containing the inoculated liquids were kept for a month at the ordinary temperature in the dark, being meanwhile shaken from time to time to promote the oxidation. Flasks containing the same dipping fluid which had been sterilised by heat were also exposed to the same conditions. At the end of the period it was found that the liquid in the control flask contained 0·222 per cent. of arsenic trioxide, whereas in the case of the inoculated samples the proportions ranged from 0·006 to 0·198 per cent. Owing to the varying conditions to which arsenical dips are exposed in practice, it has not been found possible to fix any limit of time during which a wash might be regarded as materially unaltered, and the circular therefore advises that all arsenical sheep dips should be discarded after being exposed for more than a few weeks, unless it is shown by a chemical estimation that they contain their original amount of arsenic trioxide.

SILOXIDE: A NEW GLASS.—Claim is made by MM. Wolf-Burckhardt and Borchers, in a recently-published French patent (No. 432,786 of 1911), for a new glass which is prepared by fusing together pure natural silica with oxides of the silicon-carbon group, preferably titanium or zirconium oxides or a mixture of the two. The resulting products are termed "*Z*-siloxide" or zirconium glass, and "T-siloxide" or titanium glass, and have many advantages over pure quartz glass, although they do not possess the same beautiful lustre. An experimental investigation of the new glass has been made by Mr. F. Thomas (*Chem. Zeit.*, 1912, XXXVI, 25), who finds that it is much less liable to undergo devitrification, and that it is less affected by the action of alkalies or other chemicals than quartz glass. The strongest zirconium glass was that containing one per cent. of zirconia, while the titanium glasses (containing 0·1 to 2 per cent. of titanium) were inferior to quartz glass in their power of resisting compression, but were still better than the zirconium glasses in resisting the action of heat. The new glass can be worked by the methods in ordinary use in the manufacture of glass.

AMORPHOUS SILICON.—A black silicon sulphide obtained by fusing together in an electric furnace a mixture of ferro-silicon and sulphur has been described by Dr. L. Cambi (*Chem. Zentralbl*, 1910, II, 1863). When this is hydrolysed it yields a chemically-active product. which has been found (*Atti Accad. Lincei, Roma*, 1911, XX, 440) to consist, in the main, of a variety of amorphous silicon. A fairly pure sample, containing ninety-six per cent. of silicon, had a specific gravity of 2·08, while the variety of amorphous silicon discovered by Vigouroux has a specific gravity of 2·35. This new form of silicon is a bright reddish-yellow body, which, when heated for an hour at 900° C., in the absence of air, is transformed into a heavier brown product, closely resembling Vigouroux's silicon. The impurities in the active amorphous silicon consist of hydrogen and oxygen, which are probably in combination with the silicon.

PROPERTIES OF PURE VANADIUM.—Pure metallic vanadium has been prepared by Messrs. O. Ruff and W. Martin, and a description of the methods employed and the properties of the product are given in the *Zeit. angew. Chem.* (1912, XXV., 49). By fusing vanadium trioxide with a mixture of carbon and aluminium in the alumino-thermal process, a product containing from ninety-five to ninety-nine per cent. of vanadium was obtained. Or vanadium carbide was first prepared by fusing together in carbon crucibles (heated to a temperature of 2800°C.) a mixture of vanadium trioxide and carbon, and then fusing (at 2000°C.) a mixture of this vanadium carbide and vanadium trioxide in an electrically-heated furnace.

The melting-point of the pure metal was 1715°C., and its specific gravity at 18·7°C. was 5·688. In the fused condition it would dissolve either vanadium trioxide or carbide, to form mixtures of higher melting-points than the metal.

XUM

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

THE INVARIABILITY OF IGNEOUS ROCK ASSOCIATIONS.—An interesting case of magmatic differentiation has been described from Tripyramid Mountain, New Hampshire, by Professor L. V. Pirsson and W. N. Rice (*Amer. Journ. Sci.*, April–May, 1911), which also raises the question as to how far certain associations of igneous rocks are invariable. The igneous complex, which has an oval outcrop measuring two miles by one and a half miles, is intruded into the great granite batholith forming the White Mountains of New Hampshire. It has a laccolithic habit, and a concentric arrangement of rock-types. There is an interrupted marginal zone of gabbro, with norite, followed by an unbroken zone of monzonite, whilst the interior of the mass is occupied by alkali-syenite (umptekite). The complex is accompanied by several dykes of camptonite, and is cemented along the joint-planes by dykes of aplite. The authors explain the phenomena by an hypothesis of successive intrusion with accompanying differentiation. The monzonite was intruded first with the concomitant separation of gabbro and norite on the margin. A second intrusion of monzonite then took place, with separation of the interior syenite. Lastly the joints and cracks in the solidified mass were cemented by the final residual product—a quartz-syenite-aplite. This explanation accounts for the arrangement of the rocks within the complex, and, at the same time, for the abrupt transitions and broken angular contacts between the various types.

The association of types, however, is rather unusual. Thus, alkaline types such as umptekite, monzonite and camptonite, are associated with calcic types, gabbro and norite, in the same complex. This seems to contravene the general rule, established for a great number of occurrences, that the alkaline rocks do not occur in association with the calcic, and raises the point as to whether these associations are really invariable. As Professor Pirsson remarks, some petrologists would consider the gabbro and norite as aberrant forms of essexite, the basic member which frequently completes an alkaline series. In that case, he rightly argues, the definition of essexite becomes so broad as to lose all specific value. If the Tripyramid gabbro and norite are not accepted as such, we are confronted with the alternative of calling similar rocks "gabbro" or "essexite," according to the association in which they are found.

Accepting the Tripyramid association, however, the great generalization of the invariable association of certain types of igneous rocks, based on numerous examples throughout the world, is not, we think, to be imperilled by small, isolated and exceptional occurrences such as this. Moreover, we note, from the chemical analyses given, that the norite and gabbro in this suite are considerably richer in alkalies (for a smaller silica content) than the average norite and gabbro, the composition of which is given in Daly's tables. The difficulty in nomenclature will probably be met by a closer characterization of igneous types. Thus the norites, a small, restricted, and comparatively rare group, still evidently include different varieties, not as yet expressed in the nomenclature, some of which may be associated with the alkaline, but the majority with the calcic series.

WATER SUPPLY AND THE DIVINING ROD.—The United States Geological Survey continue to issue their unique series of Water-Supply Papers. The frequency with which a second edition or reprint of many of these publications is demanded is proof of their utility to the public and an example of the excellent economic work that can be carried on by a national survey when a broadminded Government provides adequate funds for its proper upkeep. One of the latest of this series to achieve a second edition is Paper No. 255, on "Underground Waters for Farm Use," by M. L. Fuller. This paper deals in simple language with every conceivable phase of water-supply on farms and cannot fail to be of immense practical value to English-reading farmers everywhere. Seventeen well-chosen plates and twenty-seven diagrams help out difficult places in the text.

Mr. Fuller gives an interesting note on his own experience of the divining rod, the simple forked branch of witch-hazel used by the so-called water-witches as an indicator of underground water. We quote his remarks (page 15): "In experiments with a rod of this type, the writer found that at certain points it seemed to turn downward independent of his will, but more complete tests showed that this down-turning resulted from slight and, until watched for, unconscious muscular action, the effects of which were communicated through the arms and wrists to the rod. No movement of the rod from causes outside of the body could be detected. . . . . The uselessness of the divining rod is indicated by the facts that it may be worked at will by the operator, that he fails to detect strong water-current in tunnels and other channels that afford no surface indications of water, and that his locations in limestone regions where water flows in well-defined channels are no more successful than those dependent on mere guesses. In fact, its operators are successful only in regions in which ground water occurs in a definite sheet in porous material or in more or less clayey deposits, such as pebbly clay or till. . . . . No appliance, either mechanical or electrical, has yet been devised that will detect water in places where plain common sense will not show its presence just as well. The only advantage of employing a 'water-witch' . . . . . is that crudely-skilled services are thus occasionally obtained, since the men so employed, if endowed with any natural shrewdness, become through their experience in locating wells better observers of the occurrence and movements of ground water than the average person."

BRITISH PILLOW-LAVAS.—Two further occurrences, in the Tavistock-Launceston area, and in the Kilbride Peninsula, Mayo, have been added to the already long list of pillow-lavas, which are so well-developed upon several Palaeozoic horizons in Great Britain.

These rocks usually belong to the peculiar group of the spilites, in which felspars rich in soda form the major part of the rock, with subordinate augite, occasional olivine, and some glassy base. A distinctive micro-structure is shewn by the felspars, which are long, acicular and pointed, with fluidal arrangement, but often also variolitic. The spilites are associated with albite-diabase, minverite, picrite, quartz-diabase, keratophyre and soda-granite, forming a well-characterised group of rocks named by Dewey and Flett the "spilitic suite."

The new Devonian occurrences are fully described in a recently-issued Survey Memoir on "The Geology of the country around Tavistock and Launceston." They belong to two horizons, the Upper Devonian and the Lower Culm Measures. Many of them are highly decomposed and rendered schistose by pressure, so much so that it would be more correct to describe them as schalsteins. The intrusive rocks associated with the spilites are quartz-keratophyre, minverite, picrite, and quartz-diabase.

The Irish pillow-lavas are described by Mr. C. I. Gardiner and Professor S. H. Reynolds, in a paper on "The Ordovician and Silurian Rocks of the Kilbride Peninsula (Mayo)" (*Q.J.G.S.*, February, 1912), an addition to the important series of papers by these authors on the Palaeozoic Rocks of the West of Ireland. The pillow-lavas are here associated with sediments of Arenig age, and belong to a widespread and extensive series. Spilite and felsite breccias occur, proving the presence of an acid magma at no great distance, although no acid lavas have been found in the area. Later on, but almost certainly in Arenig times, one large and many small intrusions of felsite took place. No contemporaneous basic intrusions appear in the area. At an early post-silurian date, however, lime-bostonites and labradorite-porphyrites, which may form part of a later spilitic suite, were intruded.

Ordovician pillow-lavas are also known in the Girvan-Ballantrae district of Ayrshire, and Megavissey and Mullion Island in Cornwall, pointing to a spilitic petrographical province of enormous extent covering the Western British area in Ordovician times.

METEOROLOGY.

By JOHN A. CURTIS, F.R.MET.SOC.

THE weather of the week ended February 17th, as set out in the Weekly Weather Report issued by the Meteorological Office, was very dull generally, with a good deal of fog and mist in places. Temperature was above the average in all districts, the excesses varying from 2°·7 in Scotland, E., to 5°·4 in England, E. Maxima above 50° were recorded in all parts of the country, the highest being 57° reported at Tottenham, Llandudno and Killarney. The minima were below the freezing point in all districts except England, E., and the English Channel. The lowest reading reported was 25° at West Linton on the 11th. In the Channel Islands the temperature did not fall below 38°. On the grass readings down to 18° at Dublin and 19° at Aspatria, were observed.

Rainfall was slightly in excess in England, N.E., the Midlands, and England, S.E., but was in defect elsewhere, the greatest defect being in Scotland, N., where it was but one-fourth the average amount. Sunshine was less than usual in all parts except Scotland, N. In that district the daily duration was 2·2 hours (24 %), while in the English Channel it was 2·7 hours (27 %). In England, N.E., however, the daily amount was only 0·2 hour (2 %). At several stations the week was sunless. Westminster reported 0·7 hour (7 %).

The mean temperature of the seawater round the coasts varied from 37°·9 at Burnmouth to 46°·7 at Salcombe, and was, as a rule, a little above the normal.

The week ended February 24th was cloudy and damp, with fog and mist on the coast. Temperature continued high and was again above the average in all districts, by as much as 7°·4 in England, E. A maximum reading of 60° was recorded at Birr Castle, Ireland, on the 22nd, the next highest reading being 58° at Hawarden Bridge, near Chester, on the same day.

In Jersey the highest reading was 56°. Frost was recorded in all districts except the English Channel, where the minimum was 39°. The lowest of the minima reported was 25° at Llangammarch Wells, but the thermometer on the grass at that station fell to 20°. At Dublin the grass thermometer was as low as 19°. The temperature at one foot below the earth surface was above the normal at all stations and by as much as 5° in the South-East of England.

Rainfall was in excess in all districts except England, N.W., the difference from average being considerable in places, especially in Ireland.

Sunshine on the other hand was in defect in all districts except Scotland, W., where it was slightly in excess. The sunniest district was Ireland, S., with a daily value of 2·8 hours (28%). At Westminster the daily amount was only 0·1 hour or 1 per cent.

The temperature of the sea water was higher than usual, and the mean values varied from 38°·0 at Burnmouth to 48°·1 at Salcombe.

The week ended March 2nd was very unsettled, with rain on most days. In the extreme N. and N.W. the rain was sometimes heavy. Temperature continued above the average, the excesses above the normal being very high, 10°·0 in England, E., and nowhere less than 6°·2. The maxima, however, did not exceed 60° at any station, but this value was recorded at many stations between York and Jersey. The high average was due to the high minima, and in each district the average of the minima this week was higher than the normal average temperature, the excess in England, E., being as much as 4°·6. On the grass the lowest readings recorded were 23° at Rauceby and 24° at Crathes and Markree Castle. The earth temperature at one foot depth was higher than normal at all stations.

Rainfall was slightly below the normal in the Midlands and North-Eastern districts, but was in excess elsewhere, especially in the North. At some stations the total precipitation was more than twice as much as usual. Thus, at Stornoway the total was 2·84 inches as compared with the average of 0·99 inch, and at Newton Rigg 1·38 inches compared with the average of 0·67 inch. Sunshine was below the normal in all parts, the sunniest district being the English Channel with a daily mean of 3·4 hours (32%). Of the individual stations, Torquay recorded the most sunshine, 3·8 hours per day (36%). The sea temperature varied from 38° at Burnmouth to 50° at Plymouth and Scilly.

The week ended March 9th was again unsettled, with frequent rain at many stations in the West and South-West. A feature of the week was a well-marked line squall that travelled from the S.W. of Ireland to the S.E. of England on the 4th, accompanied by sharp thunderstorms and exceedingly heavy gusts of wind. The maximum velocity recorded in this squall was eighty-nine miles per hour at Falmouth (Pendennis), but a few hours later a gust of ninety-eight miles per hour was recorded at the same station.

Temperature was again above the average in all districts, the excesses, however, being of less amount than in the preceding week. The high average was due as before to the high minima, for the maximum nowhere exceeded 58° which was the reading at Jersey on the 5th. In most districts the maxima for the week were below 55°, and in Scotland, W., the highest reading was only 50°. The minima, on the other hand, were high and there was but little frost. The lowest reading recorded was 28° at Nairn and at Balmoral on the 8th. In Scotland, W., the temperature did not fall below 34°, and in the English Channel the lowest reading was 36°. On the grass, however, severe frost was registered, the readings falling to 20° at Crathes and to 21° at Plymouth and Southampton. At a depth of one foot the earth was much warmer than usual. Rainfall was slightly below the average in Scotland, N. and E., but above it in all other districts. In England, S.W., and the English Channel, the totals were nearly three times the usual quantity. The week was much more sunny than those which immediately preceded it, and daily averages were reported up to 5·1 hours (46%) in Ireland, S. All the districts showed excesses except England, N.E., and the English Channel, which were slightly in defect.

The mean sea temperature ranged from 39°·9 at Burnmouth to 49°·0 at Newquay, which was considerably above the average.

The past "Winter," that is, the period of thirteen weeks, December 3rd, 1911, to March 2nd, 1912, has been on the whole warm and wet, but dull. In England, S.E., of the thirteen weeks six were unusually warm, five normal and two cold; nine weeks were unusually wet, three normal and one dry, but only two weeks unusually sunny, one normal and ten dull.

MICROSCOPY.

conducted with the assistance of the following microscopists :—

ARTHUR C. BANFIELD.
THE REV. E. W. BOWELL.
JAMES BURTON.
CHARLES H. CAFFYN.
ARTHUR EARLAND, F.R.M.S.
RICHARD T. LEWIS, F.R.M.S.
CHAS. F. ROUSSELET, F.R.M.S.
D. J. SCOURFIELD, F.R.M.S.
C. D. SOAR, F.L.S., F.R.M.S.

AN ATTRACTIVE "COMMON OBJECT."—An interesting but perhaps little-known micro-object, plentiful in spring, may be found at the base of old dead nettle stems. The stem should be carefully drawn out from the ground after first loosening the earth round it. On examination it will be found in nearly every case, that under the cuticle just above the root, there are a number of little black points. With a moderate magnification they are seen to be flagon or bottle shaped bodies; when not crowded many are very symmetrical in form, while others owing to pressure and crowding are more or less mis-shapen. They have a narrow neck which pierces the cuticle, appearing on the exterior as a minute papilla with an orifice at the summit. These are specimens of the ascomycetous fungus *Sphaeria acuta*. If the stem supporting them is carefully dried they form an attractive object for a low power—say one inch or one-and-a-half inches—under incident light especially with a binocular. With very little trouble a preparation showing their minute structure may be made. For this purpose they should be detached with as little injury as possible, and should be soaked in strong spirit for some hours; then a little glycerine (dilute)

XUM

may be added and they can be left in this mixture for any length of time convenient. After a few days, they will lose their brittleness, and can be opened out with needles. They will be found to be filled with long narrow sausage-shaped bodies, with very thin transparent walls, sometimes difficult to see. These are *asci* and are interspersed—packed in as it were—with fine threads—the *paraphyses* (Figure 176, A). The asci each contain eight rather long, generally slightly curved spores, pointed at each end, and divided by from five to

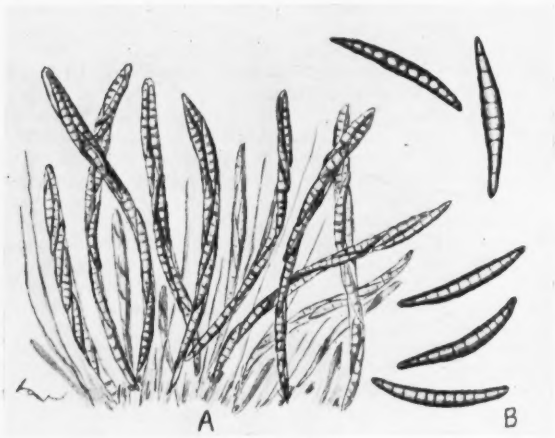


FIGURE 176.

eleven cross walls (Figure 176, B.) They are arranged in a double row with the ends overlapping, frequently in a spiral manner, see Figure 176, A. It may happen that the flask-shaped body contains only minute simple spores, free in the interior without any asci, in which case the specimen is an incompletely developed form of the same organism and has received the name *Aposphaeria acuta—vide* Dr. Cooke's "One thousand objects for the microscope" No. 336. Almost certainly another form exists also, and is probably included in the genus *Macrosporium*, as a species closely related to the one we are considering (*Sphaeria herbarum*) is known in one stage as *Macrosporium sarcinula, vide* "KNOWLEDGE" for October, 1911, page 406. The asci and spores mount nicely in glycerine jelly, or they may be stained and mounted in glycerine. The figure was drawn from a specimen treated in this way; the *paraphyses* (A) ×180 and the separate spores (B) ×310.

JAS. BURTON.

THE PYGIDIUM OF A FLEA, as mounted by Topping, was formerly sold as a test object, but although in consequence of the improvements in objectives it is no longer regarded as such, it is still an object of great interest to the microscopist on account of its intricate structure, and it has also a claim for consideration inasmuch as it represents a class of organs which are comparatively rare in the insect world. A pygidium, properly so called, is the terminal segment of an insect's abdomen, whether or not it bears the peculiar structure usually known by that name. "The pygidium of a flea" as commonly understood, is a paired organ, the two halves of which are in close proximity, enclosed in the same band of chitine and separated only by a narrow ridge of short spiny hairs; the length of the ridge in the specimen before me is one-seven hundred and fiftieth of an inch, whilst the breadth of the entire organ, including the ridge is one four-hundred and eightieth of an inch. The anterior margin of the band is smooth in outline, but the opposite side terminates in two processes each of which carries a long stiff spine and is surrounded by numerous hairs of shorter growth. The general surface of each lobe of the pygidium of a flea is studded with minute papillae, short and bulbous at the base, but tipped with a sharp apical spine, and amongst these are placed a number of curious circular depressions, or areolae, the two-thousandth of an inch in diameter, bordered by a ring of chitine from the inner margin of which seven to ten truncated wedge-shaped plates, about one-quarter the diameter of the disc, radiate towards the centre, somewhat like the spaces between the spokes of a cart wheel. From the bottom of each depression a long delicate filamentous hair arises from a conical base and passes through the central opening of the areola. The number of areolae in the pygidium varies according to the species of flea—in that of a cat it is twenty-eight, but in that of an abnormally large specimen of doubtful origin in the cabinet of the Quekett Microscopical Club there are no less than sixty-four, together with a pair of remarkable appendages extending from either side of the anterior portion of the pygidium, which have not been noticed elsewhere. As regards the function of this organ there has been much speculation. All observers agree that it is a sense organ, but of what sense has been a matter of dispute, though the balance of evidence is certainly in favour of its being an organ of hearing. Those who have watched a flea when feeding will have noticed that whilst the head is so much depressed as to preclude observation of its surroundings by the eyes, the abdomen is so elevated as to make the pygidium the highest portion of the body, in which position it would undoubtedly be best situated for perceiving the sound of approaching danger. The Lace-Wing fly, *Chrysopa perla*, has a similar organ on either side of the last segment of the body, the use of which is also problematical; the following observation, however, tends to support the idea that the function of the pygidium is auditory.

Some years ago a friend in Natal informed me that he had frequently noticed that when a Cicada was singing, it was attended by a number of Lace-Wing flies which were apparently attracted by the music, and from their movements appeared greatly to appreciate it. Many futile attempts were made to capture some of them, but as soon as my friend's approach was perceived the Cicada ceased its song and the audience took flight. At length, having one day noted their exact position on a tree trunk, he approached stealthily from behind, and by suddenly clapping his hands upon the place, succeeded in securing ten of the flies in question, which were subsequently identified as *Notochrysa gigantea*. The method of capture did not conduce to the specimens being in very good condition, and being very dry when they reached England it was not possible to dissect them with hope of success, but enough was seen to show that each of these flies had a large and prominent pygidium on each side of the last segment of the abdomen, each of which bore not less than forty areolae with a long sensitive filament upstanding from the centre, although the radiating plates appeared to be absent.

R. T. L.

THE FINE ADJUSTMENT.—Provision for the focussing movements of a microscope is made by means of slides, consisting of fixed and moveable parts accurately fitted together, one of them carrying the tube. The two parts are either dove-tailed one into the other, or made up of a sleeve fitted over a fixed prismatic bar, usually of triangular section. A micrometer screw is used to convey movement directly to the slide bearing the tube, or indirectly through a lever or some other mechanical arrangement for reducing

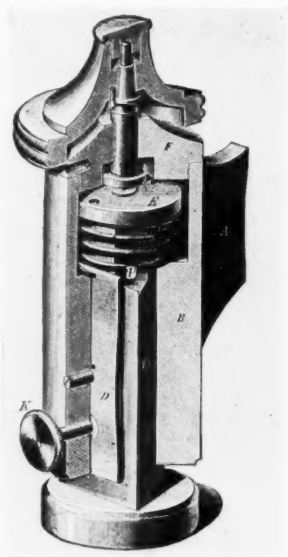


FIGURE 177.
Prismatic Bar Fine Adjustment.

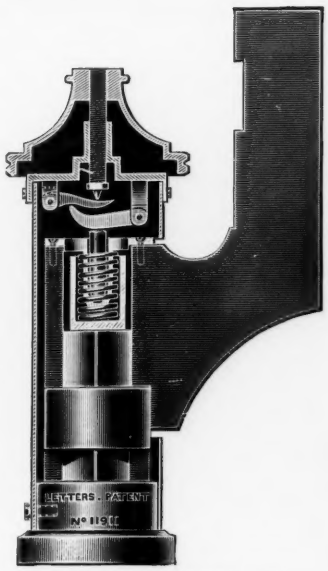


FIGURE 178. Ariston Fine Adjustment.

only, with the advantage that the arm may be lengthened to give greater stage-room without adding to the weight borne by the fine adjustment. A direct-acting micrometer screw is under these conditions inconvenient, and some intermediate mechanism is usual, generally a lever, but a few makers use a cam or some adaptation of the principle of a wedge. There are many different varieties of these broad types, and the methods by which the screw or lever, and so on, are utilized, are more or less special to individual makers. The six examples given are selected as showing a fairly wide range.

THE DIRECT-ACTING MICROMETER SCREW OR PRISMATIC BAR FINE ADJUSTMENT. Figure 177 shows the form adopted by Zeiss. The arm (A) and tube of the microscope are carried on a sleeve (B) which slides upon a vertical triangular bar (C). A nut (E) is screwed on to the top of (C) and a spring presses against it and against (B). The hardened steel point of the micrometer screw bears on the similarly hardened centre of (E) and works through (F) which is screwed to the sleeve. When the micrometer screw is turned downwards the tube travels upwards and the spring is compressed. The latter in its turn causes the downward motion as the screw is turned up. This then is a safety fine adjustment, as the objective cannot be screwed by it down on to the cover glass. Most prismatic bar fine adjustments are liable to damage if the microscope is lifted by the moveable sleeve, but in this case the danger to the micrometer screw is minimised by fixing it to the tube carrier. If the microscope is lifted by the latter the screw is lifted too, while the lower part of the instrument drops until stopped by the counter-nut screw on top of the prismatic bar.

THE ARISTON FINE ADJUSTMENT.—The fineness of motion imparted by a direct-acting micrometer screw obviously depends on its pitch, which is generally about one-fiftieth of an inch (·5 mm.), and one rotation of the milled heads raises or lowers the microscope tube through that distance. This is not a very slow motion, though adequate for most purposes, and several methods have been adopted to make the movement slower. It is not advisable to use much finer screws, as they are very liable to damage. Messrs. Swift reduce the speed to one-fifth by interposing two levers, while retaining the general characteristics of the prismatic bar type as shown in the Ariston fine adjustment. (See Figure 178.) This and most other prismatic bar fine adjustments differ from that of Zeiss in that the pressure of the spring raises the microscope tube, while the action of the screw presses it downwards; that is, they are not generally of a safety type. On the other hand, the Ariston has the great advantage over most in that the moveable sleeve carrying the limb has a protecting cover screwed over it, by which the microscope may be lifted without damage to the mechanism. The Spencer Lens Company give similar protection by fitting a small guard below the limb.

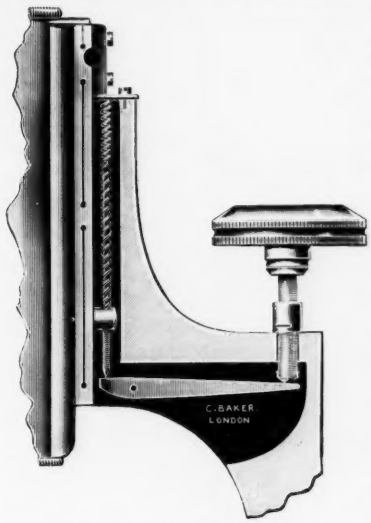


FIGURE 179. Lever Fine Adjustment.

LEVER FINE ADJUSTMENT.—Figure 179 shows a simple but very efficient way of using the lever in fine adjustments, a method that, with variations, in detail is very largely employed on English and American stands. It has the following points of interest. By placing the fulcrum of the lever in suitable positions, any desired ratio can be got between the upward motion of the end of the lever carrying the tube and the downward movement of the other end caused by the screw. A very fine motion can consequently be obtained from an ordinary micrometer screw. For instance, Watson and Beck provide a movement of one three-hundredth of an inch with a screw of one-sixtieth of an inch pitch. In the form adopted by Baker the screw is of one-seventieth of an inch pitch and the arms of the lever are as three is to one, so that one rotation of the milled head raises the tube one two-hundred and tenth of an inch. It is a safety adjustment, as the downward motion is caused by the weight of the tube and the spring, which also keeps the lever always up to its work against the screw. The bearing points and surfaces are, as in all the adjustments, of hardened steel. And the limb can be used as a handle without any danger to the mechanism.

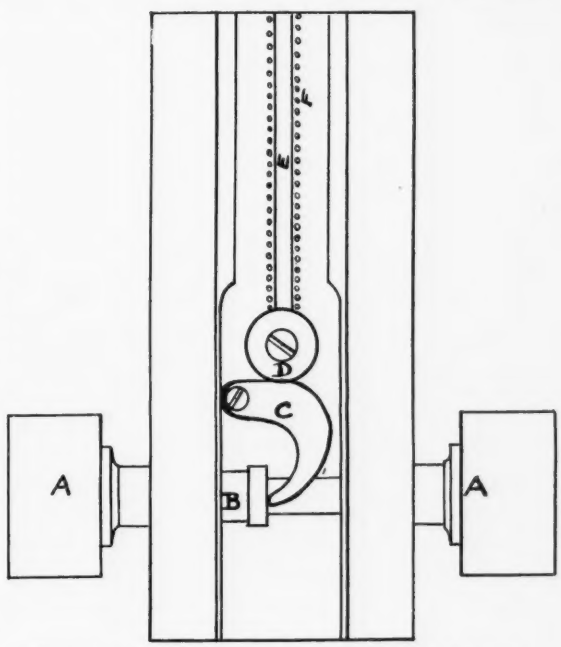


FIGURE 180. Baker's New Lever Fine Adjustment.

XUM

Baker's New Lever Fine Adjustment.—Figure 180 is from a drawing of Baker's new lever fine adjustment, and is given as an example of the methods employed for utilizing a lever when the milled heads are placed at the sides. Beck's and the Spencer Lens Company use other forms of levers for the same purpose. At (A) are the milled heads; the thread of the micrometer screw (B) is fifty to the inch. Motion is conveyed by a curved lever (C), whose ratio is one to four, to a narrow wheel (D) intended to eliminate friction as much as possible. The lever is curved where it touches (D) in such a way as to ensure that the latter carrying the tube is raised an equal amount for each rotation of the milled heads. A spring (F) on the guide pillar (E) keeps the wheel down to its work and causes the downward motion. Each revolution of the milled heads corresponds to a movement of ·125 millimetres or one two-hundredth of an inch. All slides in this and the last adjustment are sprung and screwed.

The position of the milled heads found in this fine adjustment is very much in favour now, and adopted by many makers, but it must not be supposed that that indicates a similarity in the working parts enclosed in the limb. That of Zeiss, for instance, is actuated by a micrometer screw (see Figure 181).

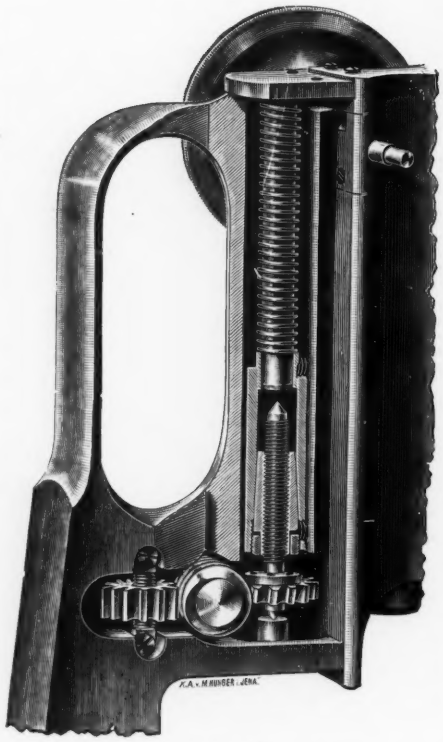


Figure 181.
Berger Micrometer Screw Fine Adjustment.

Berger's Micrometer Screw Fine Adjustment.—(Figure 181). The milled heads actuate a worm which in its turn rotates a cogwheel attached to the micrometer screw. The latter works in a socket firmly fixed to the sliding bar, so that if the milled head is turned to the left the tube will be raised. When turned to the right the socket is brought downwards on to the screw by the spring and tube weight only and disengages from the screw should the objective touch the cover glass. The guiding cogwheel to the left moves up or down as the milled heads are turned until it reaches the casing and so acts as a stop to the maximum and minimum movement of the adjustment. One rotation of the milled heads gives a movement of one two-hundred-and-fiftieth of an inch or 0·1 millimetres.

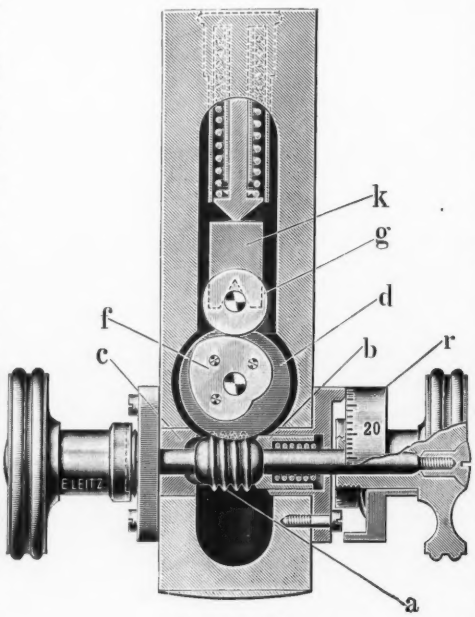


Figure 182.
Leitz' New Fine Adjustment.

Leitz' New Fine Adjustment (Figure 182) is illustrated as an example of one of the fine adjustments in which mechanical arrangements other than a screw and lever are employed. The lateral milled heads convey motion to a wheel (d) by worm gearing. This wheel carries a heart-shaped eccentric cam (f), and on this a steel roller is pressed by the weight of the tube assisted by a spring. As the cam is turned the roller which revolves upon it is lifted upwards carrying the microscope tube with it, or falls by the weight of the latter and the spring. One revolution of the milled head corresponds to a rise or fall of ·1 millimetre ($\frac{1}{25}$-inch). Examination of the figure will show that instead of a limit to the movement of the milled heads in both directions, as there is with most fine adjustments, the motion is continuous and a further rotation when the tube is raised or lowered by the cam to its greatest extent instantly reverses the motion. The rise and fall due to the rotation of the cam is three millimetres, so that reversal need very seldom occur. Continuous fine adjustments have the advantage that there is no fear of damage due to the arrival of the movement at its upper or lower limit. But the uncertainty as to whether one is focussing up or down is occasionally a drawback, although a glance at the indicator on the sliding bar and limb serves to show the direction of movement, and as the milled heads can be made to work in the same direction as those of the coarse adjustment at any time the difficulty should seldom arise.

The milled heads of any fine adjustment can be had graduated in fifty or one hundred divisions, so that the amount of motion given can be determined when required for purposes of measurement.

The testing and selection of a fine adjustment is almost as important as the choice of objectives; for unless the former is satisfactory it is impossible to use the lenses to their best advantage. The work put into modern microscopes is so uniform in quality that the efficiency of any adjustment fitted by a maker of repute may be relied on. One may be slower in motion than another, but it is not fair to say on that account that it is better, unless the use to which the instrument will be put is known. A movement of one-fiftieth or one-sixtieth of an inch for each rotation of the milled heads is quite adequate for low and medium powers, and in many cases preferable to a slower one as more durable and tending to save time in laboratory work. But for high powers and particularly for photo-micrography it is difficult to get too slow a fine adjustment. The advantages of a fast and slow motion are often combined in the same instrument by fixing a spindle of small diameter to the centre of the milled head. It may be rapidly rotated when a faster movement is desired. Secondary levers are sometimes added to reduce the speed of a fast type, as in the Ariston, or the Males-Watson, which is provided with two milled heads. Becks use two concentric micrometer screws of different pitch to actuate their lever fine adjustment, giving movements of one-sixtieth and one-three-hundredth of an inch respectively.

Safety types have a distinct advantage over other

adjustments, and the liability to damage of the adjustment itself must not be overlooked.

The position of the milled heads should be such as to permit of the hand or arm resting on the table while using them.

Above all, particular attention must be paid to the sweetness and steadiness with which the adjustment works, and the following faults should on no account occur in use: Backlash, loss of time or sag on reversal of movement, lateral movement of the object across the field. And there should be no tendency for an object to go out of focus if the table receives a slight jar.

These are all guarded against by well-fitting slides and the provision of suitable springs to keep the mechanism up to its work. Good working properties are ensured in different ways by different makers and it will be well in this connection to compare the advantages claimed for *sprung and ground-in slides*. If the adjustment slides of various microscopes are examined, some will be found to be "sprung" or slotted and held up true with screws, while others are not. Reliance, in the second case, is placed on the fit produced by grinding one part into the other. In support of sprung slides it is urged that when play through wear becomes noticeable, it may be taken up by tightening the screws and without returning the microscope to the maker. But against this advantage must be placed the difficulty of so exactly adjusting the screws that the slide works truly throughout its entire length and not only at a greater or less number of points. The alternative method of grinding one bearing part accurately into the other is now generally acknowledged as the better, but it involves the expenditure of much time in making a good fit and the use of very good materials if it is to wear well. Play is generally less than that in sprung slides, but when it does occur the microscope must be sent to the maker for readjustment. A good fitting should last for many years without any undue evidence of shake.

H. LLOYD HIND, B.Sc., F.I.C.

QUEKETT MICROSCOPICAL CLUB.—February 27th, Annual General Meeting. The Presidential Address was delivered by Professor E. A. Minchin, M.A., F.R.S., who took as his subject "Some speculations with regard to the simplest forms of life and their origin on the earth." The most distinctive property of living things is the power of metabolism. All living bodies consist essentially of protoplasm which is composed mainly of proteins. In all living organisms certain granules of a peculiar substance, chromatin, are found in the cytoplasm. Chromatin consists of protein substances more complex even than those found in the cytoplasm. The simplest forms of life appear to be little or nothing more than minute grains of chromatin. There are two views with regard to the nature and composition of the body in the simplest and most primitive forms of life; the first, the chromatinic theory, assumes that the primitive living substance is chromatin, and that the earliest forms of life were minute particles of chromatin; the second, the cytoplasmic theory, regards the cytoplasm as the primitive living substance, and supposes that the earliest living things were composed of cytoplasm alone. As an example of theories which maintain that life originated on the earth, that of Sir Ray Lankester was mentioned, according to which it is supposed that life originated at the time when the earth had cooled down sufficiently to have a firm crust upon which water was condensed. The chemical and electrical disturbances which undoubtedly then occurred might conceivably have brought about synthesis of organic compounds in a manner and to an extent which does not occur at the present day. This synthesis might conceivably have culminated in proteins and the production of the earliest protoplasm, and the earliest living things would probably have been relatively large masses of cytoplasm, in which chromatin was a product formed later. As an example of theories which assume that life was in some way brought to the earth when it was cooled sufficiently for life to exist upon it, that of Professor Arrhenius was taken. He regards life as eternal and coeval with our universe, and believes that it exists throughout the universe in the form of minute particles (? chromatin), which are transported through infinite space by radiation pressure. A particle in size of the order of $0{\cdot}16\ \mu$ would be required, and it is probable that some of the almost invisible microbes of certain diseases (Chlamydozoa) are of smaller dimensions than this value. It is not possible to decide in favour of the one theory or the other in the present state of our knowledge of living things.

ORNITHOLOGY.

By HUGH BOYD WATT, M.B.O.U.

CASUAL BIRDS IN THE BRITISH ISLES.—Birds as a class are great vagrants, and the avi-fauna of the British Isles is steadily being augmented by new species, such as those which have been reported in recent numbers of "KNOWLEDGE." These, with other very rare occasional and accidental visitors, may be called natural "casuals." It is difficult to draw a line between rarity in the occurrence of a species and casualness, for it is not adequate to say that, in the last-named, what is called "chance" must be present. Under quite natural conditions it seems to be the same factor of chance which shapes the destiny of those bird-waifs, many different kinds of which have now occurred in the British Isles, often blown or strayed out of their course on migration. In illustration of the large casual or occasional element amongst British birds it may be said that, of the four hundred and fifty species or thereabouts now admitted to our list, no fewer than two hundred and seven are classed as occasional visitors and not breeding. These cannot all or always be correctly called casuals, but a large number of them have the most slender claims to be called British. Of the two hundred and seven, some one hundred and five have not occurred more than six times each, and some of these only once or twice.

A much less questionable casual element is composed of foreign species, mostly introduced by man, and taking to freedom for a time or tentatively. This excludes such birds as the Pheasant and Red-legged Partridge which have been long naturalized in this country. Accidental or temporary introductions are a different thing, and the following incident is suggestive of what may have often happened, although perhaps not in quite the same way. When the steamer "Minnehaha" was wrecked on the Scilly Isles, in April, 1910, a number of American birds on board, consigned from New York to the Zoölogical Gardens, London, were liberated to give them a chance to save themselves. Amongst them were Parrotlets, Ground Doves, Inca Doves, Crested Quails, Red-winged Starlings and Purple and Bronze Grackles, which, if finding their way ashore, would make a strong casual element for, at any rate, a brief time in the avi-fauna of the place. Ships, unwittingly, and sailors and travellers purposely, often bring foreign animals of different kinds to our country, birds probably most abundantly. When the steamer "Mauretania" was about five hundred miles out from New York, eastward bound, on 15th June, 1911, a Curlew came on board and remained for three days, leaving only when the Irish Coast was sighted (Coward's "Migration of Birds." 1912. Page 122). No doubt it made the land and thus joined the bird population of the British Isles. Even native species are sometimes so conveyed, as the case of the Peregrine Falcon given in the last issue of "KNOWLEDGE" (page 116) shows.

The spire of Shoreditch Church was the home of a solitary Falcon for many years, and Kites which were liberated from the Zoölogical Gardens, London used to return there to feed. A Black Kite, which had escaped from its cage there, would fly over the heads of visitors quite unconcerned, in the hope of having tit-bits thrown to it. The sight of this raptorial bird on the wing caused so great a panic amongst the smaller birds in the aviaries that after a week's freedom it was induced to return to its cage. A still larger bird of prey which has accidentally been at large in London is the Vulture. In August, 1898, five Jamaican Vultures were free in the Borough, haunting the house-tops and steeples for some days; and in the same month one, which was consigned to the Hungarian Exhibition, Earl's Court, escaped from a broken crate and took to such freedom as the neighbouring roofs afforded.

XUM

When it is remembered that ornamental Water-Fowl of many kinds are kept in partial freedom in a large number of places both public and private, and that numbers of foreign species are amongst them, it is only too sure that escapes take place and form casual and irregular and unjustifiable additions to "British" birds. Recent examples of this kind are the American Wigeon, Baikal Teal, Ruddy Shellduck, Snow Goose and probably the American Bittern, and the list could be continued indefinitely. Some of these birds also occur truly wild. On the ponds in St. James' Park, London, some forty different kinds of birds are kept, and at places like Woburn Park, Bedfordshire, many species of non-British geese, ducks, and other water-fowl breed year after year successfully. Some other foreign birds are at liberty at Woburn all the year round, such as Red-Crested and Dominican Cardinals, which nest in the gardens and have young. Orange Weavers have made a nest there, but no eggs were laid. There are also numbers of the Australian Crested Pigeon (*Ocyphaps lophotes*) and the Bronze-Winged Pigeon (*Phaps chalcoptera*) in the Woburn Woods at large. Australian Doves, liberated from the Zoölogical Gardens, bred in the trees in the grounds and in the park, and some wandered off. There is a definite record of the escape from Woburn of a South American Lapwing (*Vanellus cayennensis*), which was shot some distance away as an unknown bird.

Flamingos have occurred very rarely wild in this country, but it is known that birds of this kind sometimes get away from Woburn and, no doubt, from other collections also. One, for instance, seen feeding on the Glamorganshire coast, in December, 1908, was supposed to be a bird which had made its escape from Cardiff Castle three weeks previously. A Flamingo recently flew, assisted by a gale of wind, from the Zoölogical Gardens, London, into the open park and going out of sight over the tree-tops was given up for lost, but circling round in the air it returned to the park and was secured. An odd "Zoo" story is that of a young Penguin which about a year ago escaped and was discovered walking along Baker Street (so the newspapers stated at the time). Later on the same bird was missing again and was believed to be in hiding in Regent's Park and living on the fish in the lake.

At present there is a pair of red-breasted Cockatoos at liberty from the "Zoo" and there is no intention of recapturing them, so long as they do no mischief. They take long flights in the Gardens and at dusk fly off and roost in the elms in Regent's Park. It is not unlikely that they may nest in the spring in these high trees and thus be genuine casuals, as this hardy bird can well take care of itself. In 1908, one was shot which had been robbing a poultry-yard in Glamorganshire. It was mistaken for a hawk, being quite wild, and the place from which it had escaped could not be ascertained, nor the time during which it had maintained itself free. It has sometimes been suggested that Parakeets might be liberated in English parks as ornamental birds, but this would be dangerous as, if becoming abundant, they might do damage to growing crops and to some of our native birds. At present Ring-necked Indian Parakeets, belonging to Mr. W. Jamrach, are at liberty at Stoke Newington, and come down to feed in the poultry-yard. They live day and night in the open and if they survive, it is proposed to liberate others there.

Pekin Robins (*Liothrix lùteus*) have been tried in St. James' Park, London, and probably elsewhere, but, so far as I know, without success. American Robins (*Turdus migratorius*) were turned out near Guildford in 1908 or 1909, and freely nested there, increasing in numbers considerably. To such introductions as these ornithological purists are strongly opposed, particularly if success is attained. The case of the Little Owl (*Athene noctua*), which has now established itself in many places in England, is looked upon with reprobation, and that of the Willow Grouse (*Lagopus albus*) is considered quite as reprehensible in the areas where it has been introduced. The American Wild Turkey has been tried at Luss and Inveraray and probably elsewhere, but has not made good its footing or spread. Purple Gallinules (*Porphyriola alleni*) have been shot in various parts of England, but this is an Australian bird often kept with ornamental water-fowl, and being a great climber it can get over high wire-netting and thus escape.

The Albatros is probably the most conspicuous casual recorded in our avi-fauna. The Black-browed Albatros (*Diomedea melanophyrs*) occasionally finds its way into European waters, and one was taken alive near Linton, Cambridgeshire, in 1897. I believe that instances are known of Albatroses having been brought over the line on board ships, and allowed to fly off on the northern side. They would be likely to take a northern course, and this may account for the occurrence of the species in Europe (J. F. Green, "Ocean Birds," page 4). The one or two old records in England of the Tropic-bird (*Phaeton*) may be accounted for by conveyance by ships, or may have been caused by violent storms.

There is a remarkable instance of a Bird-of-Paradise (a hen Rifle-bird) living in freedom for ten weeks in Sussex. Hens of this species were imported from New Guinea into this country for the first time in 1908, and one managed to escape when being transferred from its travelling cage to the large aviary for which it was destined near Groombridge. It was lost sight of from 7th September till 19th November, and was supposed to have completely disappeared, when, on the last-named date, it stunned itself by dashing against the window of a house about two miles away from the place where it had escaped. It soon recovered and was found to be in good health, and was committed to the aviary for which it had been intended. It is a demonstration of the hardiness of such birds, and probably a unique casual case in our country.—*Read before the Hampstead Scientific Society, February 8th, 1912.*

MENDELIAN EXPERIMENTS.—At the scientific meeting of the Zoölogical Society, London, on 6th February, two papers on Mendelism were read. The first, by Mrs. Rose Haig Thomas, described a breeding experiment which she had carried out with pheasants in order to confirm one previously made in which a cock pheasant had transmitted the female plumage of his species to his female offspring of the F 2 generation. This second experiment was conducted with the Formosan pheasant (*P. formosanus*) and the Japanese pheasant (*P. versicolor*), and produced a similar result. The second paper, by Mr. J. T. Cunningham, dealt with the characters of a number of individuals of the F 2 generation, reared from a cross between a Silky hen and a Bankiva cock, bred in the Society's gardens by Mr. D. Seth-Smith. The author described the various characters in detail, and remarked that the most important results obtained were imperfect segregation in the F 2 generation in at least two of the characters—*viz.*, absence of pigmentation in the plumage, and also in the skins and tissues.

PHOTOGRAPHY.

By EDGAR SENIOR.

INFLUENCE OF ULTRA-VIOLET RAYS.—In "Notes" for last month we showed how the suggestion put forward by Fox Talbot in 1844 had been practically realized in the taking of the portrait which formed the illustration. Not only, then, will these dark rays act to such an extent upon the sensitive plate as to enable us to produce images by their aid, but they may be the means of causing trouble in quite an opposite direction; for if the sensitiveness of the plate depends upon the absorption of these rays by the silver salt, and the body upon which the light falls either partially or entirely absorbs them itself, it is obvious that little or no action would take place upon the photographic plate. To test this it is only necessary to write upon white paper with a solution of the same substance (quinine sulphate) that was used to make the dark region of the spectrum visible, and then to take a photograph, using the same screen that was previously employed to cut off all visible light, when upon development a strong image of the writing, "which was invisible to the eye on the paper," will be produced, owing to the sulphate of quinine having absorbed the ultra-violet rays, with the result that the writing is rendered as black on a white ground in the print from such a negative. We

thus see that the absence of these rays, owing to the action of the substance itself upon them, might be the cause of serious trouble in photographing when the silver salt in use was mainly sensitive to them, or the light particularly rich in such. It is thus evident that the photographic rendering of certain bodies is influenced by the nature of the plate employed and the kind of light used in illuminating the object. We will suppose that a wash drawing has to be copied, and that it is illuminated by the light from an enclosed arc, and that the negative is made upon a wet collodion plate. Now the light itself is rich in ultra-violet, and the wet plate very sensitive in this region. The result is that a negative could be taken with a comparatively short exposure. If for the wash drawing we substitute our white paper with the invisible writing upon it "made with quinine sulphate" quite a strong image would be obtained upon the wet plate owing to the substance having absorbed those rays which produce a strong action upon the plate, with the result that the sensitiveness of the silver salt has been apparently destroyed in those parts, and a negative image of the writing which will show as dark upon a more or less white ground in the print, results. Sulphate of quinine, however, is not the only body which behaves towards light in this way. Chinese white is a notable example and in the case of drawings in which this is used and the photographs taken under the conditions enumerated above, the effect is either to produce a black or a very degraded white. Owing to this difficulty other whites have been introduced, but unfortunately bodies are present as well, which may complicate matters by setting up chemical action, that may result in the white assuming a tint which is photographically very non-actinic. That this is the case can be very readily understood when we come to consider the pigments with which drawings are made and their close proximity and admixture with the white itself. Then, again, the medium with which the white is ground may exert some influence, and from some experiments made, this appears to be the case, as pure oxide of zinc photographs differently according to the method used in preparing the pigment. If we use other sources of light for the illumination, such as daylight or the open arc, again the results differ, so that the only really satisfactory test as to the photographic value of one of these pigments, is to make negatives under precisely those conditions that obtain in practice. But even then we shall only gain information as to how the white would photograph when used under ideal conditions; it will not tell us what the result might be were some other substance present in so small a quantity as not to visually alter its colour and yet photographically it might do so to a considerable extent.

EXPOSURE TABLE FOR APRIL.—The calculations are made with the actinograph for plates of speed 200 H and D, the subject a near one, and lens aperture F16.

Day of the Month.	Condition of the Light.	Time of Day.			
		11 a.m. to 1 p.m.	10 and 2	3 p.m.	Remarks.
April 1st	Bright	·10 sec.	·13 sec.	·15 sec.	If the subject be a general open landscape take half the exposures given here.
,, ,,	Dull	·25 ,,	·27 ,,	·3 ,,	
April 15th	Bright	·09 sec.	·12 sec.	·13 sec.	
,, ,,	Dull	·21 ,,	·25 ,,	·28 ,,	
April 30th	Bright	·08 sec.	·1 sec.	·12 sec.	
,, ,,	Dull	·19 ,,	·2 ,,	·24 ,,	

PHYSICS.

By ALFRED C. G. EGERTON, B.Sc.

VAPOUR PRESSURE.—When a substance is situated in an enclosed space there is a certain pressure set up within that space, owing to the tendency of the substance to vaporise. At any particular temperature an equilibrium is set up between the molecules leaving the surface as vapour and those condensing back on the surface as liquid or solid. As the temperature rises so the vapour pressure increases. Ice at 0° C has a vapour pressure of 4·6 millimetres of mercury; ice at 10° C, about two millimetres; water at 100°, seven hundred and sixty millimetres. When the vapour pressure is the same as the external pressure, then the liquid boils; thus water boils at 100° when the barometer stands at the normal pressure of seven hundred and sixty millimetres. If the vapour pressure of a solid is greater than that of the external pressure, then the solid will vaporise without liquefying. An example of this is solid carbon dioxide, which has a vapour pressure, at so low a temperature as −60°, greater than the atmospheric temperature, and goes over into gaseous carbon dioxide without liquefaction. Now gold boils at a temperature about 1000° C, that is to say, its vapour pressure is seven hundred and sixty millimetres at its boiling-point. As the gold cools, so its vapour pressure decreases and becomes so small that, at ordinary pressures, the vapour pressure is undetectable. It would be very interesting if the vapour pressure curves of metals could be carried down to very small values; the shapes of the curves would no doubt show whether the molecules associated as the temperatures decrease and the molecules of the metal become larger and heavier. It is known that in solution in mercury the molecules of most metals are simple atoms. It is difficult to conceive of iron, brass and common metals of that sort having a definite vapour pressure at ordinary temperatures and losing weight gradually—the effect is so small as to be undetectable by known means: and it is possible for a crystalline material of homogeneous composition that the molecules are so closely packed that the vapour pressure is absolutely nil, and no molecules whatever are able to leave the surface. When the substance is definitely crystallised and when the molecules possess so little kinetic energy that they cannot leave the surface, one would expect the vapour pressure to become zero. The vapour pressure of mercury has been measured at temperatures below 0° C and has a very small value (·0008), but the pressure of the solid mercury is so small as to be unmeasurable. Vapour pressures of less than a hundred-thousandth of a millimetre cannot be measured as yet.

The methods of measuring small vapour pressures may be sub-divided into two main classes—dynamic and statical. The former class contains such methods as depend on the passage of some inert gas over the material under investigation and estimation of the amount carried over in a certain time. The second class measures directly the actual pressure set up by the vaporising substance. Some have used a very thin copper vane dividing a vessel into two chambers. Into one chamber the substance is introduced and the two chambers are then evacuated and closed: any difference of pressure is then measured by the deflection of the copper vane, such deflection being detected by causing light falling on the copper vane to interfere with the waves of another beam of light. Another method, employed by Dewar and others, depends on the change in rate of action of a "radiometer" as the pressure is altered. A radiometer is an instrument which consists of a light vane mounted within a fairly high vacuum—heat waves falling on one side of the vane, heat that side and increase the motion of the gas molecules in its neighbourhood and the vane is repelled away from them. Sir William Crookes discovered this action and the experiments led him later to the study of electric discharges in high vacua and the discovery of the cathode rays. Lord Rayleigh devised a sensitive manometer to measure small differences of pressure—by tilting the manometer, the levels of liquid in the two limbs can be brought so as just to touch two very fine points—the amount of tilt being measured by reflection of a spot of light from a mirror. A method of measuring low pressures of great ingenuity has been devised by Pirano. This consists of a specially constructed electric filament lamp of fine tungsten or platinum wire. The resistance of the wire in one such lamp is balanced against that of another. The one lamp is connected to the apparatus containing the substance the vapour pressure of which is required; this raises the pressure of the gas ever so slightly in the one bulb, and hence heat is conveyed away from the wire by the gas faster than from the wire in the other bulb

XUM

and the balance of resistance changes according as the temperature of the wire of one of the bulbs alters. The method appears accurate, but is of very limited application.

Next, the MacLeod gauge should be mentioned—most low pressure measurements are made by means of such an apparatus: but the values obtained are only reliable under certain circumstances. This apparatus consists of a large bulb with a small tube connected to it. Gas in the large bulb can be pushed up into the small tube and measured under atmospheric pressure—from the change in volume from the large volume of the bulb to the small volume of the tube, the change in pressure from some low value to be found, to atmospheric pressure can be obtained from Boyle's Law "that the volume of a gas varies inversely as the pressure upon it, if the temperature is constant." However, the reliability of Boyle's Law at very low pressures is not absolutely certain, though experiments do tend to show that at low pressures the laws about gases still hold—and, further, the mercury itself has a certain vapour pressure which is entirely unmeasurable and neglected by this instrument. The walls of the tubes also are apt to condense vapours in their pores. Measurements of the pressure within X-ray tubes and electric lamps are made by means of the MacLeod gauge—the gauge gives an idea of the degree of vacuum attained, but is unreliable for absolute measurements of pressure.

The subject of vapour pressure is intimately connected with that of smell. The nasal nerves are capable of detecting a very small quantity of a substance—it is possible that one molecule of a substance, if it gets properly into contact with the sensitive portion of the nasal organ, might affect it perceptibly. The quantity of a gas, such as bromine, which is detectable is very small indeed, and the pressures of vapours detectable by smell are smaller than can be directly measured. The effect is probably of a chemical nature—a loose combination, perhaps, is formed between the molecules of the vapour and the substances of the nasal organ—it is noticeable that the smells of all oxidising substances, when dilute, are practically identical, which seems to show that the effect produced by them on the nasal organ is similar. The sensitiveness of the nasal organs of animals is well established, and it is indeed marvellous to think that sufficient molecules which can be smelt are left behind by a person who has passed a locality perhaps an hour previous to the arrival of his dog!

There is much interesting work to be done in this direction, and I have thought it worth while to draw attention to it in this month's notes.

SEISMOLOGY.

By CHARLES DAVISON, Sc.D., F.G.S.

THE ORIGIN OF EARTHQUAKES.—In a lecture on "The elastic-rebound theory of earthquakes" (Univ. of California Publications, *Bull. of the Department of Geology*, volume VI., pages 413–444), Professor H. F. Reid discusses a theory of the origin of earthquakes which has long been known, and I believe generally accepted, in this country. The theory is that earthquakes are due to the friction caused by the sudden sliding of the rock-masses adjoining a fault-surface, that they are, therefore, merely passing incidents of secondary importance in the growth of faults. Professor Reid bases his account of the theory on the remarkable displacements of the crust along the San Andreas fault which gave rise to the Californian earthquake of 1906. He sums up the theory in the following terms: "1. The fracture of the rock, which causes a tectonic earthquake, is the result of elastic strains, greater than the strength of the rock can withstand, produced by the relative displacements of neighbouring portions of the earth's crust. 2. These relative displacements are not produced suddenly at the time of the fracture, but attain their maximum amounts gradually during a more or less long period of time. 3. The only mass movements that occur at the time of the earthquake are the sudden elastic rebounds of the sides of the fracture towards positions of no elastic strain; and these movements extend to distances of only a few miles from the fracture. 4. The earthquake vibrations originate in the surface of fracture; the surface from which they start has at first a very small area, which may quickly become very large, but at a rate not greater than the velocity of compressional elastic waves in the rock. 5. The energy liberated at the time of an earthquake was, immediately before the rupture, in the form of energy of elastic strain of the rock."

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A.

AQUATIC VERTEBRATES OF SAHARA.—It seems strange to speak of the freshwater fauna of the great desert, but it is a reality and of very considerable geographical interest. Besides a crocodile (*Crocodilus niloticus*) and a turtle, there are eight Amphibians and ten fishes. The interesting point is this, as J. Pellegrin points out, that while the more northern part of Africa has a Palaearctic Mediterranean fauna, the aquatic vertebrates of the Sahara are distinctively Ethiopian.

ORIGIN OF GERM-CELLS IN SILK-MOTH.—Another instance of the early segregation of the future germ-cells has been found by Vaney and Conte in the development of the egg of the silk-moth. At an early stage, when the blastoderm has been formed and the germinal disc marked off, two large cells appear between the blastoderm and the yolk which seem to form the future germ-cells. The segregation is not so precocious as in some other insects (the harlequin fly, *Cecidomyia*, and Chrysomelid beetles), but it is nevertheless a good instance of the early separation of the germ-plasm from any share in body-making.

PEARL MAKING.—A. Rubbel has made a very careful study of pearl formation in the freshwater mussel, *Margaritana margaritifera*, and is against the theory that they are the sepulchres of parasites. He finds that they arise around particles of a yellow substance, which resembles periostracum. They originate in closed, single-layered sacs of epithelium, which are constricted off from the external epithelium of the mantle, and, like the mantle, are able to secrete all the layers of the shell. The pearls grow by the deposition of layer after layer on their surface. The coalescence of several pearl sacs leads to the formation of curious pearl conglomerates. What are called shell pearls are formed, to begin with, in the mantle, and become secondarily attached to the shell. They are to be distinguished from shell concretions, which are due to intruded foreign bodies and show no concentric layering. Besides rejecting the parasitic theory of pearl formation, Rubbel calls attention to an overlooked fourth layer in the shell. It is a clear intermediate layer, dividing the nacreous layer into an outer and an inner stratum; it is particularly clear at the muscle insertions, but it occurs in other parts of the shell and in the pearls.

THE TURTLE'S EGG-LAYING.—S. O. Mast gives an interesting account of the behaviour of the Loggerhead Turtle in depositing its eggs. He watched the process on Loggerhead Key, Florida, in the month of July. The animal came straight out of the water about seven o'clock in the evening and proceeded directly up the beach for fifty or sixty feet. There seemed to be no selection of a place for the nest. By moving the posterior part of the body from side to side, and by throwing out the sand sideways and forward alternately with the hind flippers, she dug a trench four feet long and nearly ten inches deep in the middle. In this trench in a very complicated way she made a cylindrical hole nearly as deep as the length of the hind flippers. Into this hole the eggs were dropped—perhaps a hundred altogether. Noise and gentle touching did not cause any interruption. After laying the eggs the turtle covered them up, filling the trench as well as the hole. "This completed, she returned to the sea and entered only a few feet from the spot where she came out. On the way down the beach I stood on her back and she carried me (165 lbs.) apparently with but little effort." The turtle under observation was out of water forty-two minutes, spending three in reaching the nesting-place, four in making the trench, eight in digging the hole, twelve in laying the eggs, and fifteen in filling up, smoothing over and getting back to sea. The rate of locomotion on land is about half a mile an hour.

BORING BIVALVES.—For a long time there have been two theories in the field with regard to the method by which Pholads and other bivalves bore through rocks. According to one theory the boring is at least partly due to an acid secretion; according to another theory it is mainly accomplished by mechanical means. B. Lindsay has studied *Zirphaea* (*Pholas*) *crispata* and *Saxicava rugosa*, at St. Andrews, and comes to the conclusion that the boring is in these cases entirely mechanical. The *Zirphaea* works in two ways—sucking and scraping; "it might be described as a combination of a nutmeg-grater and a vacuum-cleaner." The foot is extruded; a wide gap appears between the foot and the mantle; the mantle becomes fully extruded, and then rotatory movements begin. The shells consist of aragonite—harder than the usual calcite—and this must help in the boring.

DISCHARGE OF SPERMATOZOA IN FRESH-WATER MUSSEL.—Oswald H. Latter gives an account of this process as he saw it in May of last year. A specimen of *Unio pictorum* emitted from the exhalant aperture a fine double stream of milky substance, which rose nearly to the surface of the water and then fell as a diffused cloud. The whole of the water in the aquarium became cloudy and the emission continued for some hours. It appeared to be under control, for a slight shaking of the floor was followed by a cessation of the streams though the ordinary exhalant current of water appeared to continue without interruption. The liberated material consisted of myriads of sperm-balls, revolving and swimming like Volvox, and finally breaking up into the component spermatozoa which exhibited astonishing activity, sustained below a cover-slip for seven hours after liberation.

THEORY OF GALLS.—Jules Cotte makes some very interesting remarks on the origin of "zoöcecidia"; that is to say, galls made by animals. He points out that there is often a striking structural resemblance between the animal-made gall and the plant-made gall; that animals far apart from one another seem able to make very similar galls; that the same animal produces very diverse galls; that an animal which causes galls at one place or at one season may be inoffensive at another; that there is sometimes a puzzling disproportion between the dimensions of the gall and the number of alleged producers; that some galls continue to grow after the parasites have disappeared, and that others are formed before the ovum of the parasite has been hatched. All this leads up to the theory that many so-called animal-made galls are due to moulds or bacteria or the like introduced by the animal. The insect or mite is a carrier of a vegetable infection, and in many cases the zoöcecidia are demonstrably associated with fungoid growth. Cotte does not deny that there may be true zoöcecidia, but he thinks that many are more accurately described as myco-zoöcecidia or phyto-zoöcecidia.

SOLAR DISTURBANCES DURING FEBRUARY, 1912.

By FRANK C. DENNETT.

FEBRUARY has yielded a much better proportion of dates when telescopic scrutiny of the Sun was possible than either of the two previous months. Only on three days (8th, 13th, and 16th) did he escape observation. The central meridian at noon on February 1st was 108° 45′.

No spots were observed during the month, though there were some faculic disturbances as shown on the diagram.

On February 2nd and 3rd, a group within the eastern limb occupied the area between longitudes 27° and 37°, and south latitude 3° and 6°.

On the 17th and 18th a facula within the eastern limb was situated at longitude 180°, south latitude 9°.

On the 24th some faculae near the western limb must have been about longitude 245°, and near to the equator, but were not measured. Also on the 24th and 25th a faculic disturbance was noted within the eastern limb, a little over 10° south latitude and near longitude 88°.

On the 27th a small facula was situated at longitude 205°, north latitude 20°, and so near the north-western limb. A larger and paler disturbance, containing a dull patch near its eastern end, was also approaching the western limb, and situated between longitudes 90° and 200°, south latitude 6° to 8°.

On the 29th a facula, doubtless that seen on the 17th and 18th, was approaching the western limb in south latitude.

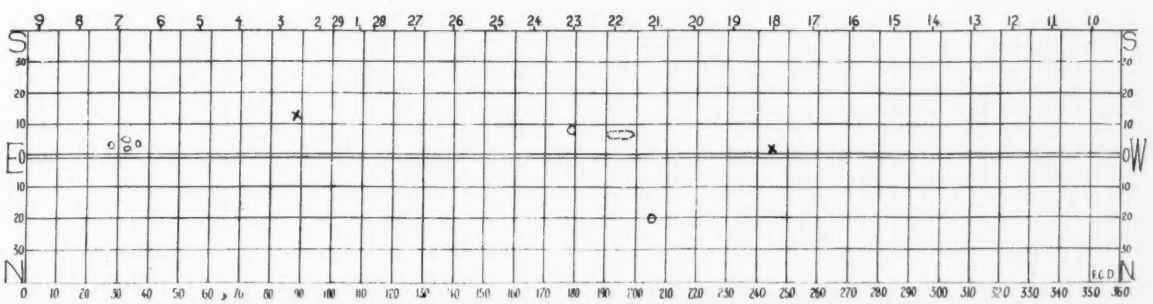
Mr. E. W. Maunder, writing at the desire of the Astronomer-Royal, kindly tells us that "two small faint spots in the middle of a little group of faculae were photographed at the Cape Observatory on December 18th last. One of the spots remained to the next day, when it was smaller but darker. It was photographed at Greenwich on December 19th. The positions as measured were:—

Dec. 18.—Long.	295°·3	... Lat. N.	22°·7
„ 18.— „	293°·5	... „ N.	24°·2
„ 19.— „	295°·1	... „ N.	23°·3"

This district would cross the Sun's central meridian only a little after midnight on December 21–22. It almost appears as if it were the starting of a new cycle of solar activity, and also interesting as occurring in the northern hemisphere as was foreshadowed.

Our chart is constructed from the combined observations of Messrs. John McHarg, A. A. Buss, E. E. Peacock, W. H. Izzard, and the writer.

DAY OF FEBRUARY.



REVIEWS.

BIRD-MIGRATION.

The Migration of Birds.—By T. A. COWARD. 137 pages. 4 illustrations. 6¾-in.×4¾-in. (The Cambridge Manuals of Science and Literature.)

(Cambridge University Press. Price 1/- net.)

To write on the subject of bird-migration within the limits of a small manual is an act of some courage, but Mr. Coward may be congratulated on the success with which he has accomplished his work. It is however significant of the state of mind which the subject seems to induce to find the penultimate chapter headed "Suggestions and Guesses"; reliable and definite conclusions seem still far to seek. In the earlier chapters a good and clear account is given of theories which have been promulgated, old and new, and many of the facts and incidents ascertained by observers in different countries—the British Isles, Europe and North America—are stated and drawn upon in illustration. These are full of interest, even although sometimes more like curiosities of natural history than anything else. Ornithophaenology, "the accumulation of substantiated observations and facts," Mr. Coward remarks, "will not prove everything" (page 6), but it might be added that without these, properly co-ordinated and classified, nothing can be proved. Such systematic work would prove, in the end, more useful and satisfactory than theories and speculations.

A good bibliography is given, and although it is stated that a full one has not been attempted, yet it is curious to find mention of only two of the long and still continued series of "Reports on the Movements of Birds in Scotland," and none at all of the British Association "Reports on the Migration of Birds" (1880-1887), or of the current series of reports published by the British Ornithologists' Club.

H. B. W.

CHEMISTRY.

The Chemistry of the Radio-Elements.—By F. SODDY, F.R.S. [Monographs on Inorganic and Physical Chemistry.] 92 pages. 8¾-in.×6-in.

(Longmans, Green & Co. Price 2/6 net.)

The process of specialisation in different branches of Chemistry has reached such a stage that no one can hope to keep in touch with the whole of the science. Moreover, even in the special branches, the literature is so widely scattered throughout scientific journals all over the world, that important contributions may readily escape notice. These drawbacks have already been met in the case of biological chemistry by the publication of a valuable series of monographs, the object of which has been to summarise the present state of our knowledge of the particular subject, and to serve as a sign-post to those who are travelling in the same direction.

This idea has now been extended, and in the present monograph we have the first of a series intended to deal in a similar manner with different branches of inorganic and physical chemistry, each to be written by an acknowledged authority.

In the book under consideration we have an excellent outline of the new subject of radio-chemistry, and a summary of the results of the most recent investigations. After a general description of the nature and phenomena of radio-activity, sections are devoted to each of the radio-active elements, including the interesting cases of potassium and rubidium, and the book concludes with a table of references, an index, and a chart illustrating the genetic formation of the elements successively produced in the disintegration of uranium, actinium, and thorium.

In a future edition it would be an improvement if the references were classified under their respective headings. With this exception we have nothing but praise for the book, which may be heartily recommended both to the research student and to the general reader who has some slight knowledge of chemistry and is interested in its latest developments in this direction.

C. A. M.

A Text-Book of Inorganic Chemistry.—G. SENTER, D.Sc., PH.D. 583 pages. 90 illustrations. 7½-in.×5-in.

(Methuen & Co. Price 6/6.)

The appearance of new text books on inorganic chemistry has now become so perennial, that on meeting with a fresh addition to the list one's first thought is to discover why it was written. In the present instance, the answer and the justification are not far to seek, for the increasing application of physical methods to chemistry, which has led to such striking developments of the latter science, has rendered both desirable and necessary the writing of an elementary text-book dealing with the subject from modern points of view. In this aim the author has been completely successful, and his book should meet with a warm welcome in many quarters. It covers more than the ground usually included in the examinations for the London B.Sc., but at the same time cannot be described as a "cram-book"; for practical work and the application of general theory to particular instances are skilfully interspersed throughout its whole course. For instance, the physical methods of determining the molecular weights of substances in solution are described early in the book, and their use is continually illustrated in the succeeding pages.

As those who are acquainted with Dr. Senter's book on physical chemistry would anticipate, an immense amount of information is conveyed in the clear yet concise words of the born teacher, while diagrams are introduced wherever necessary to the text. In short, the book marks a great advance upon the text-books of only a few years ago, which described masses of more or less isolated facts in the arbitrary manner that was inevitable, since important links which bound them together had not yet been discovered.

C. A. M.

GEOLOGY.

Geological and Topographical Maps; Their Interpretation and Use.—By A. R. DWERRYHOUSE, D.Sc., F.G.S. 133 pages. 90 figures. 9-in.×6-in.

(Edward Arnold. Price 4/6 net.)

This book fills a gap in the technical literature at the disposal of the teacher of geology, and is therefore assured a wide welcome. It opens with a good general account of topographical maps and their interpretation, in which one is pleased to note an insistence on the importance of the true scale in drawing both topographical and geological sections. In teaching, however, it is often very difficult to present geological structure to students without some exaggeration of the vertical scale. True scale drawing should only be introduced after the elementary principles have been mastered. A useful summary of the characters of the various maps issued by the Ordnance Survey of this country is given with explanation of the system of numbering and method of ordering. The brief and necessarily sketchy chapter on some structural features of the earth's crust might have been expanded to some purpose.

The problem of the relation of geological outcrops to contour lines is treated as following from the general problem of the mode of intersection of two contoured surfaces, one of these being the surface of the ground, the other the geological stratum considered. The directions of V-shaped outcrops in valleys is deduced easily and naturally on this method. In succeeding chapters the complications due to inclined and folded strata, unconformities, overlaps, and faults, are dealt with; together with the methods of representing igneous and metamorphic rocks in plan and section. The principles thus brought out are then applied to the elucidation of geological history from maps, and some very instructive examples are given.

The concluding chapter gives some practical advice to geologists on the methods of conducting a geological reconnaissance. This should prove most useful, as many geologists have but slight acquaintance with topographical surveying, without which geological work in a little-known and unmapped country is not only more difficult but loses much of

its value. This book seems to fulfill its purpose excellently and may be warmly recommended not only to students of geology, but also to civil engineers and others for whom the correct interpretation of topographical and geological maps is often essential.

G. W. T.

Secrets of the Hills, and how Ronald Read Them.—By STERLING CRAIG, M.A., LL.B. 320 pages. 19 plates. Numerous Woodcuts. 8½-in.×6-in.

(G. G. Harrap & Co. Price 3/6 net.)

In this book geology is genially expounded by a preternaturally wise doctor to a receptive and questioning schoolboy, Ronald. The scene is laid in Scotland, where Ronald is enabled to visit the lead mines of Leadhills, to dig and wash for gold in the same district, to descend a coal mine, and, in short, to sample many of the phases of the rich and varied geology of that favoured country. The author has managed to cover most of the field of modern geology. A simple method of question and answer is used throughout, but the more solid instruction is interspersed with picturesque accounts of Ronald's gold digging and other exploits, in such a way that the book should never pall with the right kind of boy reader. The author has taken great pains to get his facts correct and thoroughly up-to-date, and to that end secured the services of Dr. B. N. Peach, F.R.S., to read over his proofs and to make suggestions and corrections. There is consequently very little with which to find fault, a mistake such as "Unita" for "Uinta," repeated twice on page 157, and also on page 10, and an obvious misprint (page 265), being all that has attracted the reviewer's attention. The book is finely illustrated with plates, woodcuts, maps and diagrams, which might, however, have been numbered. The absence of an index is partly compensated for by a very full list of contents. Altogether this is a surprisingly interesting book, far in advance of other and older productions of its kind, and may be read with pleasure and profit by adult novices in geology as well as by the boys to whom it is primarily addressed.

G. W. T.

MATHEMATICS.

A New Algebra, Vol. II.—By S. BARNARD and J. M. CHILD. 731 pages. 87 illustrations. 7¾-in.×5-in.

(Macmillan & Co. Price 4/-.)

This volume completes the school course of Algebra for the ordinary student—a third volume is in preparation to satisfy the needs of the mathematical specialist. It is written on the old lines, but it is brought up to date with chapters on approximate values and graphs. It is certainly a book to be recommended for the use of scholars; and the excellence of the examples should make it possible to be used by less capable students. The authors have written a book that goes far to defend the position they assign to Algebra in the scheme of education; they would have rendered that position less assailable if they had had the courage to do a little pruning—why, for instance, is Harmonical Progression allowed to cumber the ground? In our opinion the pure theoretical niceties of the proofs (especially in so-called "fundamental laws") are over exaggerated—the clearness of the numerical calculation in Section 293 is more valuable educationally than pages of abstract reasoning. We wish more attention had been paid to giving in true perspective the importance of different theorem and methods; why is not Professor Hill's proof of the exponential used? ϵ is so important an actor in the world of mathematics that its entrance on to the stage should have been heralded by a flourish of trumpets; instead, we see it dragged on, clinging to the skirts of the Binomial Theorem.

F. W. D.

A Shorter Geometry.—By C. GODFREY and A. W. SIDDONS. 301 pages. 287 illustrations. 7¾-in.×5¼-in.

(Cambridge University Press. Price 2/6.)

This contains the substance of the well-known "Elementary Geometry" by the same authors, rearranged in accordance with the views expressed in the Board of Education circular. The authors point out in their preface that the new book is eighty-seven pages shorter than the old one, and that nothing essential has been omitted. Like the Shorter Catechism, the book seems long enough for most youngsters, and we have nothing but commendation for the process of curtailment. For its size the book is remarkably massive, and should make a formidable missile.

METEOROLOGY.

Our Weather.—By J. S. FOWLER, F.R. Met. Soc., and W. MARRIOTT, F.R. Met. Soc. 131 pages. 63 illustrations. 6-in.×4-in.

(J. M. Dent & Sons. Price 1/- net.)

This little volume forms one of the series of Temple Primers, of which forty-five have now been issued. It is clearly written in a very interesting way by competent and experienced authors, and touching as it does on every branch of the subject it forms a capital manual in itself and an excellent introduction to larger works. The chapter on Phenological observations is a valuable addition, since this branch of Meteorological work is frequently passed over in text books. The illustrations are numerous and good.

J. A. C.

PHYSICS.

A College Text-Book of Physics.—By A. L. KIMBALL, PH.D. 692 pages. 610 illustrations. 8¾-in.×6-in.

(London: G. Bell & Sons. New York: Henry Holt & Co. Price 10/6 net.)

This book belongs to the class, now somewhat numerous, of which Ganot is the type, and it is an excellent example of that class. It is adapted to the needs of students taking the general first-year course in an American College, and contains all the Physics usually demanded as a preliminary to scientific professions in this country. It follows that mathematical reasoning is allotted a secondary place in the scheme of the book, and clear presentation of physical facts is aimed at throughout. The mathematical treatment is good as far as it goes, which is perhaps no further than would, to use a phrase of Sir J. J. Thomson's, "give a headache to a caterpillar." Thus Newton's formula for the velocity of sound is given without proof: in fact, the methods of the calculus are not employed, and the proof of the formula for acceleration of uniform circular motion is hardly as sound as it might be. Lenses are treated by the method of rays, and although the diopter is not introduced, convex lenses are taken as positive, and concave as negative. It is doubtful whether the formula and the rules given for using it are any easier for the indifferent mathematician than the old-fashioned treatment. There is an excellent section on "Fluids in Motion"; and it is surprising to find in a book with so many practical applications a treatment of machines in which friction and efficiency are disregarded. The chapters on "Heat" seem rather short. On the other hand, "Light," and particularly "Diffraction," obtains full attention. The book is well worth the consideration of teachers and students.

W. D. E.

Pyrometry.—By C. R. DARLING, F.I.C. 200 pages. 60 illustrations. 7¾-in.×5-in.

(E. & F. N. Spon. Price 5/- net.)

This little manual, which is based upon lectures given before the Society of Arts, deals, as its title suggests, with the measurement of high temperatures, above the range of the mercury thermometer. It gives clear descriptions, with illustrations, of the different types of pyrometric apparatus, and fully explains the principles upon which they are based, so that there should be no difficulty in understanding the way in which they are used.

The book is essentially of a practical character, and fills a distinct gap in the literature of applied chemistry. It will be found of the greatest assistance to all whose work involves the measurement of high temperatures.

C. A. M.

XUM

PREHISTORIC ARCHAEOLOGY.

Prehistoric Japan.—By NEVIL GORDON MUNRO, M.D. 705 pages. 421 illustrations. 9-in.×6¼-in.

(William Bryce. Price 24/- net.)

The preface of this book is dated January 5th, 1908, but a foot-note tells us that the great number of the copies were immediately destroyed by fire. Those who are interested in European antiquities will rejoice that the work has been reprinted, for the seven hundred pages are crowded with notes and pictures, illustrating Paleolithic and Neolithic remains as well as intermediate pottery; Bronze vestiges are also dealt with, while four chapters are devoted to Yamato remains. The last chapter deals with the prehistoric races themselves and contains also some reproductions of good photographs of the Ainu. To the general reader, no doubt, the discussion on diet, dress and social relations will prove attractive. Dr. Munro holds very definite opinions, for instance, on the origin of clothing and he says that notwithstanding the confusion which has arisen regarding its primary function there can be no question that the habit of dress originated in personal decoration. As a means to an end—namely, sexual selection—it is almost impossible to exaggerate the importance of personal embellishment in modifying, sustaining, or emphasising various characters of the race.

All the same, in his following sentence he seems to recognise the adoption of clothing for reasons of coquetry, for he alludes to the alluring motive of modern ball-room costume. Dr. Munro's remarks on face-painting may also be mentioned. Red appeared to be the favourite colour, but two black spots on the forehead were affected by the court nobility of both sexes till a few decades ago, not for embellishment, as were the patches of Europe, but as a sign of rank. The painted patterns also, judging from primitive images, show a likeness to those which were originally tattooed. We congratulate Dr. Munro on having produced a most useful and attractive book.

W. M. W.

PSYCHOLOGY.

A Text-Book of Experimental Psychology, with Laboratory Exercises.—By CHARLES S. MYERS. 2 vols. Second Edition. Part I: Text-book. 344 pages. 1 plate and 24 figures and diagrams. Part II: Laboratory Exercises. 107 pages. 42 figures and diagrams. 8¾-in.×5¾-in.

(Cambridge University Press. Price 10/6 net.)

The first edition of Dr. Myers's work was published some three years ago and at once took a place in the first rank of text-books of this class. Of it a critic, writing in one of the leading American journals, said: "It is a question whether any single book contains as much information as does Myers's text-book." Both in range and quality, both in method of arrangement and in presentation, the work was admirable. The new and enlarged edition brings the treatment up to date and is worthy of the heartiest commendation. Although it is not primarily meant for the general reader, although the discussion is too thorough to afford light and easy reading, yet all those who appreciate the genuine scientific spirit, all those who feel the charm of living touch with contemporary investigation, will turn to Dr. Myers's work with profit and pleasure. There may, however, arise some sense of disappointment that so large a proportion of the space at his command is devoted by the author to sensation and to what may be termed the lower and more elementary factors in experience. But this is inevitable in any attempt to apply in psychology the touch stone of experiment. Methods of dealing with the more complex mental products and processes have only recently been devised and are on their trial. Dr. Myers has added in this edition a new chapter on Thought and Volition, in which the question of imageless thought is briefly considered. We trust that arrangements have been made by which Dr. Myers will be enabled to bring his admirable work up to date at comparatively short intervals. If this be done it will continue to retain the position which it has won.

C. Ll. M.

ZOÖLOGY.

Social Life in the Insect World.—By J. H. FABRE. Translated by Bernard Miall. 327 pages. 14 illustrations. 9-in.×6-in.

(T. Fisher Unwin. Price 10/6 net.)

This series of observations—by that well-known French entomologist, described by Darwin as an "inimitable observer"—makes most fascinating reading. By careful and patient watching, renewed season after season, he endeavours to throw light on many interesting points—as, for example, the wonderful power possessed by the female Emperor moth of attracting the males from long distances. Several chapters are devoted to the very peculiar habits of the Praying Mantis, while various other insects are similarly dealt with. The book is written in an exceedingly attractive style, and the photos by which it is illustrated complete an altogether delightful volume.

A. A.

A Junior Course of Zoölogy.—By the Late A. MILNES MARSHALL, M.D., D.Sc., M.A., F.R.S. 515 pages. 94 illustrations. 7¾-in.×5½-in.

(Smith, Elder & Co. Price 10/6 net.)

No one who in the old days used "Marshall and Hurst" to their advantage can fail to welcome the appearance of the seventh edition, which Professor Gamble has prepared for the press. At the same time it may not be amiss for one who has had many years' practical experience of the book to point out its greatest failing.

This is really nothing to do with the subject matter but with the method in which the very useful figures are labelled. If only the actual names of the parts had been written on the diagrams instead of various letters for the meaning of which the student has to turn, often to another page, much time, trouble and annoyance would be saved. The only redeeming feature is that the letters used refer to English words, whereas in some of the text books which borrow foreign clichés the trouble is augmented. The present writer was, in fact, so impressed with the need for reform in this matter that in any biological illustrations which he has prepared for students' use he has always had the full name of the parts inserted. In these days of cheap line-process reproduction the extra cost need not be considered.

W. M. W.

NOTICES.

PHOTO-MICROGRAPHY.—On Monday, May 6th, Mr. Edgar Senior will begin a course of six practical demonstrations on Photo-micrography at the South-Western Polytechnic Institute, from 7.30 to 9.30 p.m.

At these demonstrations special attention will be given to the photographing of etched surfaces of metals and alloys (Metallography), but the course will also be arranged to suit the requirements of students of Geology, Botany, and so on, and of those wishing to use their own microscopes to obtain photographic records of objects.

It is advisable that students joining this course should possess an elementary knowledge of photographic manipulation. Fee for course, 2s. 6d.

A NEW SCIENTIFIC QUARTERLY REVIEW.—On the first Tuesday in April, Messrs. Constable and Company will publish the first number of *Bedrock*, a quarterly review of scientific thought. The editorial committee consists of Sir Bryan Donkin, Professor Poulton, Mr. Archdall Reid, and Professor Turner, while the acting Editor is Mr. H. B. Grylls. *Bedrock* is an attempt to provide an arena in which thinkers possessing a common knowledge but divergent opinions can meet and endeavour to thrash them out. We sincerely hope that the editors of the new review will find ample justification for their belief that there are few scientific or social problems of which the solutions would not be hastened by the provision of such an arena.

XUM